TRANSPORT OF CHRISTCHURCH SOLID WASTE

ROAD TRANSPORT VERSUS RAIL TRANSPORT

A Dissertation
For the Degree of Master of Professional Studies
Transportation Management

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ABSTRACT

Abstract of a dissertation submitted in partial fulfilment of the requirements for the Degree of M. Prof. Stud. by I.E.B. Schriiffer

TRANSPORT OF CHRISTCHURCH SOLID WASTE

Road Transport Versus Rail Transport

This focus of this study is to analyse the logistics of solid waste transport from Christchurch (New Zealand) to the local landfill by comparing two scenarios - road versus rail transport. The thrust of the research is based on a triple bottom line approach that considers economic, environmental and community issues.

Key Words: Solid Waste Transport Logistics by Road versus Rail, triple bottom line analysis

EXECUTIVE SUMMARY

The purpose of this research is to provide an analysis of solid waste transport from Christchurch to Kate Valley, the new Christchurch landfill located approximately 70km north of Christchurch. The first part of the study identifies waste data and the overall waste management operations. The second part outlines the current road transport operation and compares in a third stage the road versus with rail operation, as for the majority of the trip the waste containers could be carried by rail. This comparative evaluation uses a triple bottom line approach that considers the economics, the environmental effects and the impacts on the community (social issues).

The study also identifies opportunities to improve the management of solid waste at the transfer stations and looks at other container options to improve the overall system.

Kate Valley landfill was commissioned in July 2005 to replace the local Christchurch landfill in Burwood, a suburb at the eastern side of the city. In 2005, more than 304,000 tonnes of solid waste were sent to landfill from Christchurch. This represented a 32% increase (61,000 tonnes) of the projected figures from the Christchurch City Council (CCC, 2006). The resource consent granted for Kate Valley is for 35 years, however at the current rate of disposal the landfill will be full in less than 28 years.

Other factors impacting on the landfill and transport operations are:

- The road transport costs likely to increase over time (140 kilometre return trip) due to Green House Gas mitigation costs.
- The price of diesel fuel rose to over $1.10 per litre in 2006.
- The number of trips to Kate Valley increased by 1300 from the figure authorised in the resource management consent.
- The increase of solid waste has put pressure on the ability of the transfer stations operation to reduce the volume of waste going to the landfill.

The solid waste is delivered to the 3 transfer station floors it is then compacted into two closed containers with a combined payload of approximately 20.4 tonnes. These containers are transported to Kate Valley using 12 Canterbury Waste Services Ltd (CWS) truck and trailer units each fitted with a hook and arm lifting system to load and unload the containers.

The study compares the currently used closed containers system (payload 20.4t per truck and trailer) with open top containers (payload approx 22.4t) to assess the benefits along the whole operation. Using open top containers and shredding the waste allows a payload of 22.4 tonne payload (see Table 1).

Based on 304,148 tonnes, open closed containers require 14,909 return trips to Kate Valley per annum against 13,578 return trips using open top containers. This represents a saving of 1,331 return trips or 186,340 kilometres per annum.

Year	Waste / Annum [t]	Closed Container Trips 20.4 [t]	Open Top Container Trips 22.4 [t]	Saving in Trips / Annum	Christchurch Population	Predictions of Waste [kg] / Person / Day
2005	304,148	14,909	13,578	1,331	345,857	2.4

Table 1 Solid Waste and per person per day figures (CCC, 2005a)

The next step was to look at using a multimodal approach to transport the waste from Christchurch to North Canterbury. This multimodal approach includes road transport at both ends of the journey, leaving rail for the main link in the middle section:

- **Road 1** Road transport from each transfer station to the nearest rail facility in Christchurch.
- **Rail** The containers are transferred onto flat deck wagons and railed from Christchurch to Glasnevin (north of Amberley - 11 km south of Kate Valley).
- **Road 2** Container transfer from rail to road plus road transport from Glasnevin to Kate Valley

The operation of a rail transfer station at Glasnevin (opposite the current CVIU weigh bridge) is unlikely to have a significant impact on the local community (if designed and managed well) but will contribute while reducing air emissions and the number of trucks travelling through local communities from Christchurch to Glasnevin.

A number of multimodal container transfer options have been considered, looking specifically at the current hook and arm lift option, the European ACTS roll on roll off, the Swiss Cargo Domino system and an overhead gantry crane option. Both Cargo Domino and the current hook system offer a one man (truck driver) operation for transferring containers. The ideal container transfer system for both, departure points in Christchurch and destination in Glasnevin need to be identified as a next step in a feasibility study.

The outcome of the triple bottom line assessment for both road and combined rail-road option under various container systems identified clearly that the rail-road multimodal transport option offers the most sustainable option for the future. It includes the following benefits compared to the current road transport:

- Reduction of operational costs (fewer trucks and drivers required)
- Substantial fuel savings (Table 2 below)
- Minimisation of air pollution, including CO2
- Community benefits through improved road safety, a reduction in congestion and noise between Christchurch and Waipara (North Canterbury)

Containers	Payload	Road Fuel Used Litres	Rail-Road Fuel Used Litres	Fuel Saving Litres	Fuel Saving [%]
Closed	20.4[t]	1,337,803	513,432	824,371	**62**
Open Top	22.4 [t]	1,223,456	492,954	730,502	**60**
Difference		**114,347**	**20,478**	**93,869**	
From closed to open top	From 20.4[t] on road to 22.4[t] on rail-road	1,337,803	492,954	844,849	**63**

Table 2 Fuel use Comparison between Road and Rail Transport Operations

In conclusion, the triple bottom line approach shows clearly that the rail-road multi modal transport option is a serious alternative to the road transport, considering the current political environment that has the objective of reducing CO2 emissions.

With the long life span of the Kate Valley landfill, further investigations are required to see how well a rail-road option will fit with the solid waste disposal in Canterbury and surrounding areas. The operational focus in the future should be on reducing CO2 emissions and maximising fuel savings with an emphasis on the collection of solid waste from strategic locations in the vicinities of rail tracks for final disposal at Kate Valley. This would maximise the investment of a modern rail-road transfer station near Glasnevin.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

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1 RESEARCH BRIEF

1.1 Introduction

This study looks at solid waste transport from Christchurch to Kate Valley by assessing the current practice against a number of other options with a triple bottom line focus.

1.2 General Overview of Waste Management

Solid waste management is a topic of increasing worldwide concern and debate. The two most common ways of disposal of solid waste is to discharge it to a landfill or incinerate it prior to dump the ashes to a landfill.

Solid waste will always end up in a landfill. However, depending on the regulations of the specific country, the waste may get sorted, recycled or treated prior to end disposal in a landfill. This can happen through mechanical - biological pre-treatment or thermal methods. Such pre-treatment systems will reduce the amount of waste and to a large extent also diminish the biological activity. However, in New Zealand, the solid waste is not pre-treated and gets discharged as fully biologically active waste to landfills (Thull, 2006d).

The debate between disposal directly to landfill and incineration has been on-going for the last forty years in developed countries. One of the major differences, philosophically, is that although disposing of waste to a landfill may be cheaper in the first stage, the on-going costs are often not predictable. Future generations will have to deal with all the residues and leachate and landfill gas associated with the landfill for years to come.

Incineration of waste means dealing immediately with things like emissions and minimising the risk to the environment for future generations. Incineration is not considered as a valid option for Christchurch. The investment costs are high and the volume of waste not significant enough to remain viable. It is also important to note that the ash from an incineration process is reduced to 30% of the original waste amount and needs to be disposed in a landfill. The incineration ashes contain substances that are highly toxic and require special care (e.g. dust particles from electro filters).

Any increase in recycling (e.g. paper and plastics) reduces the energy content of domestic solid waste, requiring additional energy (oil or coal) input to the incineration process. Although recycling is a good idea to save resources, it can be a negative to an incineration process.

Many innovative technical processes have been trialled over the past twenty years, such as the Thermoselect process which operated well in a small scale plant in Northern Italy. However, it was not able to operate properly in a large scale situation at the plant in Badenwerk, Karlsruhe, Germany as the emissions were too high. The plant was shut in March 2004 (JFE & TS, 2004).

Keeping these general waste management approaches in mind, this study endeavours to challenge the transport side. It will look at the current transport situation, identifies further options and discuss how sustainable these are from a triple bottom line point of view.

1.3 Christchurch Waste Management Situation

Worldwide there are issues associated with the transportation of solid waste, in New Zealand, with a clean green image it is no exception. Its implementation needs to be in line with the principle of sustainable development. A triple bottom line approach is defined by the list below (Land Care Research, 2006):

- A thriving economy
- Quality of life and benefits to the community for today's society and for future generations
- To protect the environment

The introduction of recycling / waste minimisation campaign, has contributed to a reduction of solid waste transported to landfills. Recycling is now a big business:

- Metals
- Glass
- Paper
- Oils
- Plastics
- Wood

and other products are being recycled as long as their recovery is profitable.

Population growth in Christchurch City and Canterbury has increased the amount of solid waste by 15% in 2005 (Transwaste Ltd, 2005).

Figure 1 below shows the actual breakdown of all solid waste quantities from Christchurch and the surrounding areas discharged at Burwood Landfill, the previous Christchurch landfill located seven kilometres north east of Christchurch.

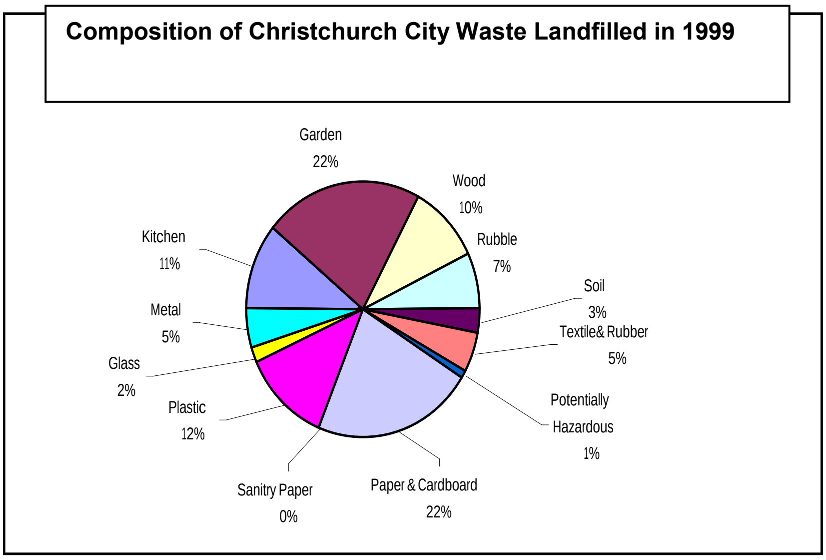

Figure 1 Christchurch Waste Breakdown for 1999 (CCC, 2005a).

In 1999, 228,000 tonnes of solid waste was landfilled at Burwood (see Figure 1), this figure increased to 263,000 tonnes in 2004 / 2005 and 304,148 tonnes in 2005/2006 (CCC 2005).

There are currently four waste streams (see Table 3): Residential / Household, Commercial Industrial, Council and Agricultural* that are collected in Christchurch and transported to the Kate Valley Landfill from the three transfer stations:

- Parkhouse Road Transfer Station
- Metro Transfer Station
- Styx Mill Transfer Station

Note The bulk of agricultural waste is often dumped in pits or private landfills on farms causing environmental pollution of the surrounding area and possible contamination of the ground water. Agricultural waste will not be discussed as part of this project.

Streams of Solid Waste in Christchurch

A/ Residential / Household	B/ Commercial & Industrial	C/ Council	D/ Agricultural

A	**Residential / Household**	
a	Solid waste (via Transfer Station)	Council kerbside collection (Onyx)
b	Rubbish Black bags	Council kerbside collection (Onyx)
c	Recycling A	Council kerbside collection (Onyx)
D	Recycling B	Residence responsibility
E	Green waste	Residence responsibility
***B**	**Commercial / Industrial**	
a	Black bags	Council kerbside collection (Onyx)
b	Recycling A	Council kerbside collection (Onyx)
c	Recycling B	Private contractor
d	Hazardous waste	Private contractor
e	Radioactive waste	Private contractor
f	Building waste	Private contractor
g	Hard Fill	Private contractor
h	Offal	Private contractor
C	**Council**	
a	Rubbish Black bags	Council kerbside collection
b	Litterbins	Council kerbside collection
c	Recycling A	Council collection
d	Recycling B	Private contractor
e	Green waste (Non Recycle)	Council collection
f	Green waste (Recycle)	Council collection
g	Road sweepings A	Council collection
h	Road sweepings B	Private contractor
D	**Agricultural**	
a	Chemicals A	Council collection
b	Chemicals B	Farm owner disposal
c	Chemicals C	Private contractor
d	Offal	Farm owner disposal
e	Recycling A	Farm owner disposal
f	Recycling B	Private contractor

Table 3 A Breakdown of Solid Waste in Christchurch (CCC, 2003).

The economic boom in Christchurch has caused the amount of waste sent to landfills to increase since 2002 (see Table 4), despite record volumes of recycling materials being recovered in the same period (CCC, 2006).

Year	Total CCC Waste [%]	Increase / Decrease [%]	Christchurch Population	Population Increase / Decrease
1999	230,822	1.00%	324,300	
2000	227,423	-2.50%	325,400	1,100
2001	215,910	-5.10%	327,200	1,800
2002	219,872	1.80%	332,000	4,800
2003	229,981	4.50%	338,800	6,800
2004	264,477	14.90%	344,100	5,300
2005	304,148	15.00%	345,857	1,757

Table 4 Christchurch City Solid Waste and Population Figures from 1999 to 2005 (CCC, 2006a).

1.4 Objectives

With the closure of Christchurch's Burwood Landfill in 2005 and the commissioning of the new Regional Landfill at Kate Valley, this research is aimed at evaluating the transport options to carry solid waste from the present three Christchurch Transfer Stations to Kate Valley Landfill using a triple bottom line approach.

This triple bottom line evaluation considers:

- Economic evaluation
- Impacts on the local environment
- Impacts and benefits in the community (social)

This research will investigate the following questions:

- Are there opportunities to improve the management of waste at the Christchurch transfer stations?
- Is the present option of road transporting of solid waste the best option available?
- Are there alternative transport options available either in New Zealand or overseas?
- Do any of these options offer a significant advantage if implemented?

1.5 Methodology

1.5.1 Introduction

The methodology is broken down into the following parts:

- Review of existing information
- Data gathering, feasibility and analysis
- Identification of further transport options and assessment of their practical feasibility
- Number crunching to compare various options

1.5.2 Review Existing Information

- Identify existing legislation and proposed changes that may impact on transport options
- Identify existing legislation regarding transport and solid waste management operations
- Identify changes that have impacted on the volume of waste in Christchurch
- Review solid waste disposal in Christchurch in the past ten years
- Search for previous studies undertaken on waste transport and container handling systems in New Zealand and overseas
- Review Environment Canterbury's Regional Land Transport Freight Action Plan and the forecast analysis on transport movement in Christchurch and Canterbury
- Review the Christchurch waste management plan
- Review newspaper articles relating to the handling and transportation of solid waste from Christchurch
- Review the resource consent and limitations placed on the waste transport process
- Review Transwate Ltd newsletters on the transport operation
- Review the resource management application for Kate Valley, the resource consent and limitations placed on the waste transport process
- Identify freight movement data in Canterbury
- Growth and environmental impact information of transport on local communities.
- Fuel and energy use regarding transport options relating to solid waste transport

1.5.3 Data Gathering

Contact Stakeholders

- Trailer and Container Manufacturers
- Transit New Zealand
- Toll NZ Ltd
- Land Transport New Zealand
- New Zealand Police – Commercial Vehicle Investigation Unit (CVIU)
- CCC
- META (NZ) Ltd
- Local Community Groups

1.5.4 Number Crunching

As part of this dissertation I intend to analyse the following information:

- The number of trips required to transport solid waste to the Kate Valley Landfill
- Compare the different transport options available to understand
    - The number of containers required for each transport option
    - Truck and trailer unit numbers required
    - Fuel consumption comparison between the transport options
- Analyse the amount of solid waste generated per person in Christchurch
- Predict the amount of solid waste for the next 10 years based on the Christchurch population trends
- Compare the CCC's projected solid waste levels to the actual solid waste figure sent to Kate Valley.

1.5.5 Analysis & Discussion

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- Energy
- Road and rail kilometres
- Formulate a checklist of key milestones to be achieved during the research project
- Analysis of the data / information gathered using an open approach to the information and by being objective with it
- Understand the business relationships between the local councils, the private waste collection contractors and the company operating the transport and landfill operation.
- Analysis of Christchurch's solid waste figure of kilos per person per day compares to the national average and overseas waste figures
- Analysis of the population figures to the amount of solid waste generated in Christchurch
- Investigate alternative waste transport options available to identify if any offer a significant advantage if implemented
- Investigate the different container transfer systems available for solid waste
- Identify and discuss possible changes to the current waste management
- Analyse and compare road transport to intermodal transport options operation

2 WASTE MANAGEMENT IN CHRISTCHURCH

2.1 Introduction

This chapter gives an historical background of solid waste management in Christchurch and the current CCC waste management plan. It provides information about the growth of the Christchurch population and the ownership and operation of the Canterbury Regional Landfill.

2.2 Historical Background

There were originally thirty landfills in Canterbury in 1999 (refer Appendix 3), however this number significantly reduced with the introduction of the Resource Management Act (RMA) in 1993. The two major landfills operating in Canterbury are Redruth Landfill near Timaru and the Burwood Landfill (soon to close) near Christchurch. Four local body landfills also remain operating but are all due to close within two years.

With the proposed closure of the Burwood Landfill looming in 1995 the CCC looked for an alternative landfill site. Several location options (Omihi, Darfield and Waipara) were evaluated; however due to public objections and local community pressure these sites were abandoned.

Opposition from local communities and their "not in my back yard" attitude towards the development of a new regional landfill became a rally point. The thought of large volumes of solid waste being dumped in their community brought out the perceived problems associated with a landfill:

- Smell
- Litter
- Environmental pollution
- Safe storage of hazardous waste
- Noise
- Vermin
- Location of storage facilities
- Increased heavy traffic volumes and accidents
- Social impact on the communities on the route
- Reduced property prices

In 2000, Canterbury Waste Services purchased a 2,757 hectare hill farm seventy kilometres north east of Christchurch. It is sited between State Highway One (SH1) and the coastline including the area of Kate Valley.

Kate Valley is to be the Regional Landfill for Canterbury. The landfill operation and transport of the solid waste from Christchurch will be undertaken by Transwaste Ltd and Canterbury Waste Services Ltd (CWS), a joint venture company between the local councils and two private solid waste company's Waste Management NZ Ltd and Envirowaste Ltd (Transwaste Ltd 2003).

2.3 Population Development and Predictions

As the population of Christchurch increases to a higher density similar to Auckland, solid waste will become more difficult to recycle. Due to high costs of recycling, more recyclable products will be dumped to landfills i.e. glass, wood, paper.

The CCC's programme to reduce the use of log burners and open fires will also result in an increase in the amount of solid waste that will be generated by Christchurch residents. The existing practise of burning solid waste in winter time will be stopped.

The Christchurch Territorial Authority (CTA) was the area used for the 1986, 1991 and 1996 census, when a new area the Christchurch Territory (CT) was introduced as the population measurement area. The Christchurch area population is now bounded by the Waimakariri River to the north, the sea to the east, up to the top of the Port Hills to Kennedy's Bush, behind Halswell and Templeton and including the area of McLean's Island and Belfast.

The Christchurch City residential population in Table 5 below shows the trend in population growth from 1986 to 2005 and the predicted population trends from 2006 to 2030.

Year	Christchurch Population		Year	Christchurch Projected Population
1986	286,601		2006	347,614
1987	286,000		2007	349,371
1988	286,700		2008	351,128
1989	287,000		2009	352,885
1990	288,300		2010	354,642
1991	292,858		2011	356,400
1992	293,700		2012	358,140
1993	297,600		2013	359,880
1994	302,800		2014	361,620
1995	308,800		2015	363,360
1996	317,500		2016	365,100
1997	321,000		2017	366,620
1998	323,000		2018	368,140
1999	324,300		2019	369,660
2000	325,400		2020	371,180
2001	327,200		:	:
2002	332,000		2025	378,780
2003	338,800		:	:
2004	344,100		2030	386,380
2005	345,857			

Table 5 Population of Christchurch from 1986 to 2005 and Predicted Population from 2006 to 2030 (CCC, 2005b).

2.4 Transwaste Ltd and Canterbury Waste Services

Transwaste Canterbury Ltd is a Local Authority Trading Enterprise owned (see Figure 2) by the local authorities and Canterbury Waste Services Ltd (CWS).

Local Authority participation in the process is via the Canterbury Waste Subcommittee reporting back to the councils involved at Council Meetings.

The Canterbury Waste Subcommittee is a subcommittee of the Canterbury Waste Joint Committee comprising two private waste management companies and the ten Canterbury Local Authorities (CCC, 2004):

- Waste Management Ltd
- Envirowaste Ltd
- Christchurch City Council
- Waimakariri District Council
- Hurunui District Council
- Selwyn District Council
- Ashburton District Council
- Banks Peninsula District Council*
- Kaikoura District Council
- Timaru City Council
- Mackenzie District Council
- Waimate District Council

* Banks Peninsula District Council amalgamated with the CCC in 2005 / 2006.

The split of capital funding for the Canterbury Waste Subcommittee is listed below in Table 6 as follows:

Council	Population (1996 census)	Capital Funding [%]
Christchurch	314,000	75.70%
Waimakariri	32,100	7.74%
Selwyn	25,000	6.03%
Ashburton	25,000	6.03%
Hurunui	10,000	2.40%
Banks Peninsula*	8,700	2.10%

Table 6 Funding split of Canterbury Waste Subcommittee (Transwaste, 2003a).

2.5 Structure of the Canterbury Regional Landfill Project

Canterbury Waste Services Ltd (CWS) was formed in 1999, it is owned by Waste Management New Zealand Ltd and Envirowaste Services Ltd

Figure 2 below Shows the ownership of the joint venture company Transwaste.

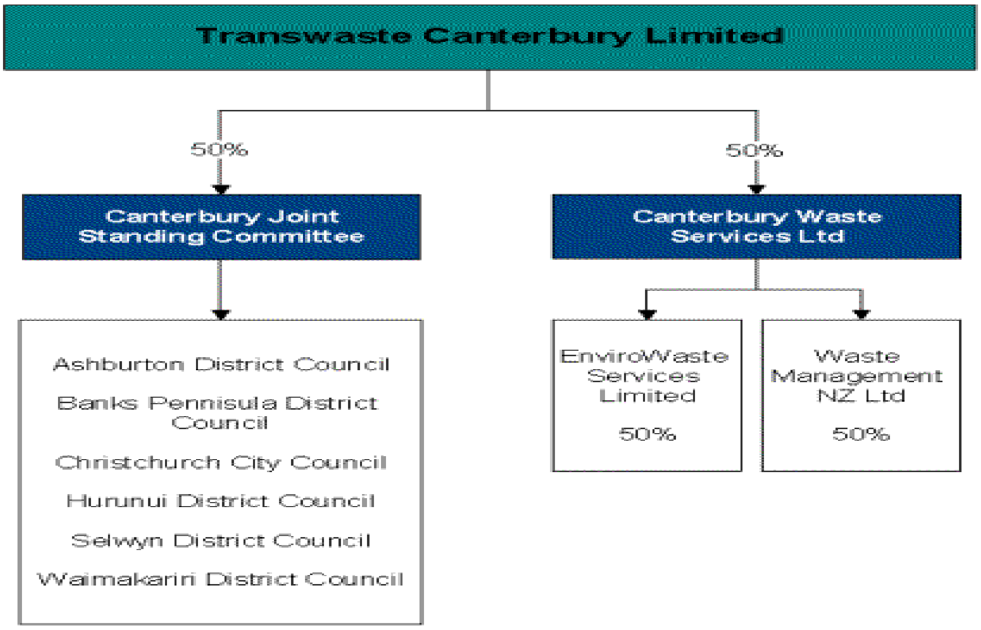


Figure 2 Ownership Structure of the Canterbury Regional Landfill Project (Transwaste, 2003b).

2.6 Christchurch City Council Solid Waste Plan

Richard Lloyd, Managing Director of the RMFC (now META NZ Ltd), is quoted as saying "In the current economic climate the level of waste being generated is higher than ever. There has never been a more appropriate time to focus on genuine and sustainable waste minimisation. The RMFC is looking forward to introducing new and innovative ways of diverting material from the waste stream for the benefit of the whole community" (CCC, 2004).

Following a public call for proposals "to meet a range of Council solid waste services and objectives", the Council decided in December 2004 to advance a scheme from the Recovered Materials Foundation Canterbury (RMFC). The nine contracts which have resulted are the product of work done since August 2003 by staff of the various organisations and expert consultants.

The CCC implemented changes on the 1st July 2005 to separate potentially useful material from the waste stream part as of the introduction of the Christchurch Solid and Hazardous Waste Management Plan.

Under RMF management, the Council's refuse stations at Parkhouse Road, Metro Place and Styx Mill Road will become "resource recovery parks" with an emphasis on recycling and reuse of the incoming materials rather than disposal to landfill.

2.7 Solid Waste Management Operation

This section gives an overview of the current solid waste road transport operation from:

- Kerbside collection to the three Christchurch Transfer Stations:
  - Parkhouse
  - Metro
  - Styx Mill
- The transfer stations operations

1 Note

The transportation of leachate from the Kate Valley Landfill is not part of this research.

The estimated leachate removal trips from the landfill in year one (2005 / 2006) was a minimum of zero and a maximum fifty two, the most likely number was fifty two return trips, published in Transwaste's Assessment of Environmental Effects, Appendix W (Traffic, 2002).

The actual figure given by Transwaste for 2005 / 2006 is three hundred and sixty five return trips, an additional three hundred and thirteen return trips per annum.

2 Note

The transportation of up to thirteen hundred trips per year of gravel to Kate Valley from the Waipara River was not allowed for in the original resource management application. Insufficient quantities of sand / gravel have been located at Kate Valley for use protecting the liner layer.

2.7.1 Kerbside Collection

The residential solid waste collection operation including black bags collection and a separate recycled material collection was previously undertaken by Onyx Waste Ltd. In February 2006, Onyx announced their withdrawal from the kerbside collection contract. This operation is now being undertaken by the CCC.

Recycling materials put out by residents in special green crates is separated in to:

- Paper: newspaper, magazines
- Cardboard: corrugated, flat
- Glass*: clear and coloured
- Metals: aluminium, steel, copper, brass and lead
- Plastics clear plastic and coloured

* Due to the high volume of glass being collected and the low price being paid, it has become uneconomic to recycle glass and it is being sent to the landfill at Kate Valley.

At the transfer Station products are sorted and stockpiled, these products are then sold to commercial business for recycling through TerraNova (Formerly Recovered Materials Foundation) and the CCC.

2.7.2 Transfer Station Operations

From the kerbside collection, solid waste is delivered to the floor of one of the three Christchurch transfer stations along with both commercial and private waste that is directly delivered.

The management and operation of the three Christchurch Transfer Stations changed from City Care Ltd to META NZ Ltd (the Resource Recovery Foundation) as of the first of July 2005.

The transfer station operations include:

- Recycling services
- Collection point of reusable items sent to the Red Shed for resale
- Hazardous waste collection

- Weights, records and volumes of materials landfilled
- Green waste (plant material) commercial scale composting operation – up to 30,000 tonnes per year
- Compacting of waste into containers for transport to Kate Valley Landfill
- Storage area for empty and full containers
- Collection point for waste tyres (reused by farmers as part of their silage operation cover)

Refer to Appendix 4 for the layout of the Styx Mill Transfer Station.

Table 7 below indicates the operation hours of the three transfer stations and an overview of the container volumes from the transfer stations to Kate Valley.

Transfer Station	Opening Hours	Closing Hours	Waste [%]
Parkhouse	5.30am	7.00pm	45%
Metro	5.30am	7.00pm	33%
Styx Mill *	7.00am*	6.00pm*	22%
Solid Waste Total [%]			**100%**

Table 7 Percentage of Waste by Transfer Station (Ross, META, 2005).

Note * Styx Mill is restricted by the resource consent allowing it to operate for eleven hours per day from 7am to 6pm, all waste must be removed from the transfer station floor every night.

3 KATE VALLEY LANDFILL

3.1 Introduction

This chapter investigates the location of Kate Valley Landfill site, the resource management court process undertaken, the New Zealand legal environment and the resource management consent for Kate Valley including the conditions and restrictions placed on the transport operation and the landfill operation.

3.2 Location of Kate Valley

The Kate Valley Regional Landfill is located in the South Island of New Zealand, approximately 70 kilometres north east of the city of Christchurch (see Figure 3). The site is located nine kilometres east from the intersection of State Highways One (SH1) and State Highway Seven (SH7)on the Mount Cass Road.

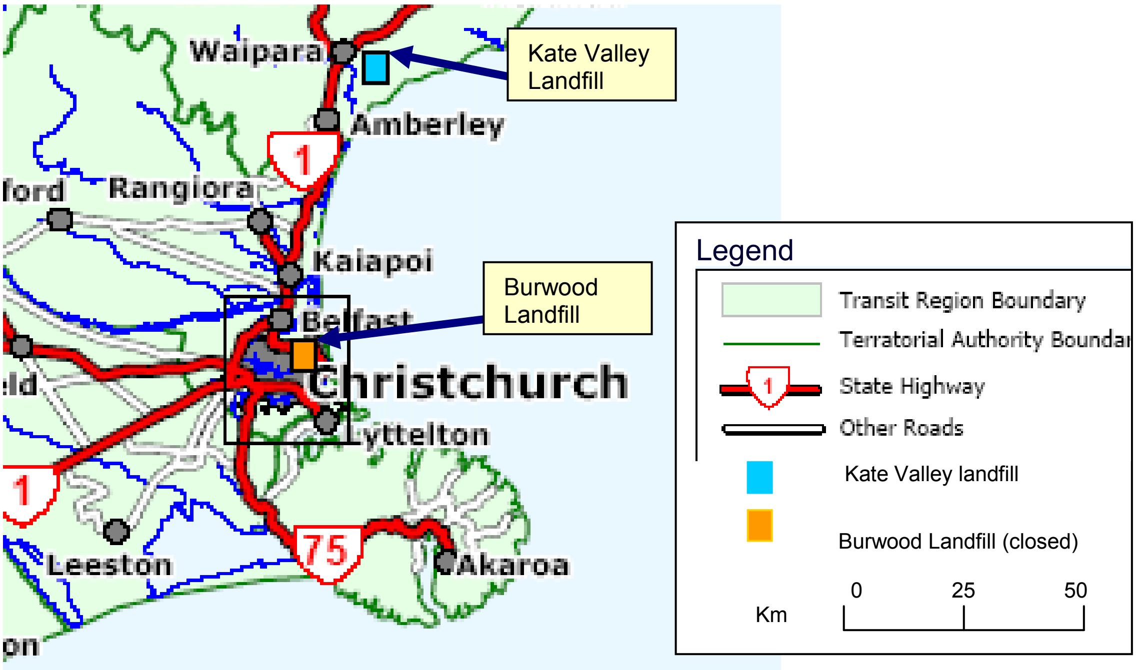


Figure 3 Location of the Kate Valley and Burwood Landfills in relation to Christchurch (Transit NZ, 2006a).

The primary business focus in the Waipara area is production of wine, forestry, farming and tourism.

The now closed Burwood Landfill (see Figure 3) located approximately seven kilometres to the north east of Christchurch. This landfill will continue to be monitored for ground water contamination of any potential environmental impacts for the next thirty years.

The map below in Figure 4 details the farm purchase by Transwaste Ltd in 2000 (the area highlighted in red), also the Kate Valley Landfill site footprint (highlighted in blue), and Mount Cass Road to the landfill site from the intersection of SH1 and SH7, south of Waipara.

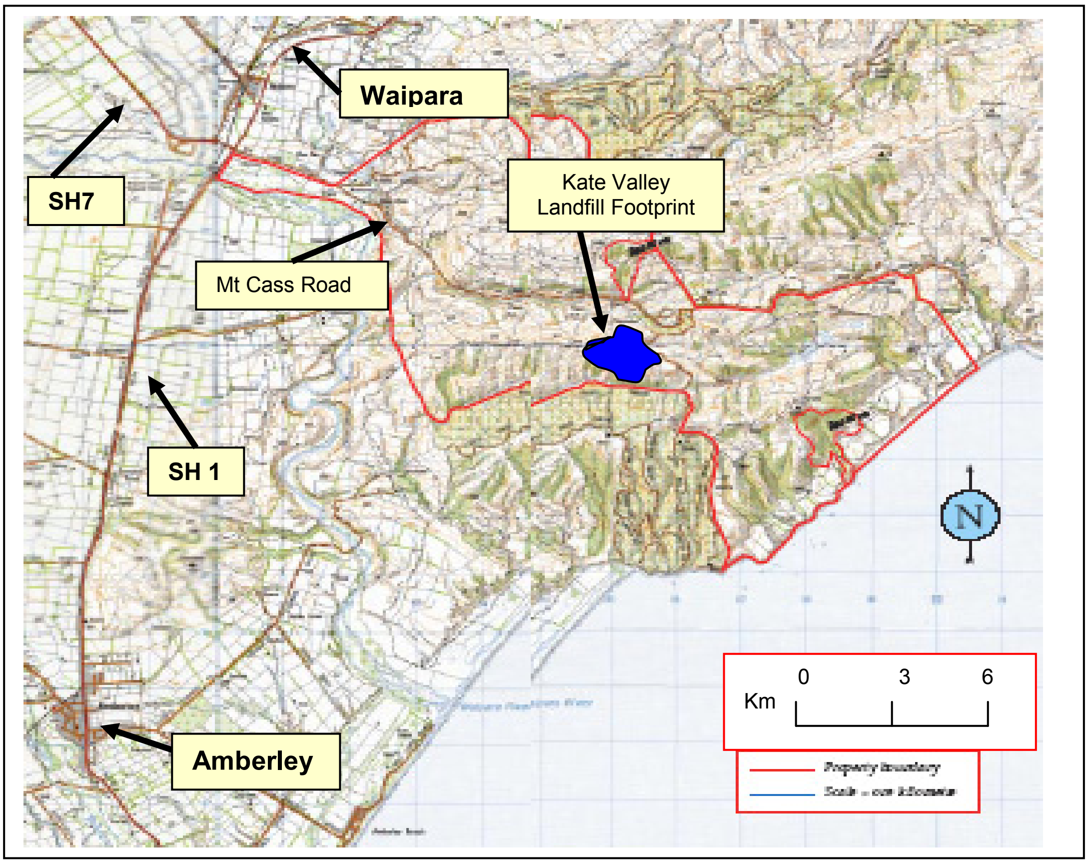


Figure 4 Kate Valley Landfill site and surrounding area (CCC, 2000).

The site preparation began in June 2004 to be ready to receive solid waste from the opening date in July 2005.

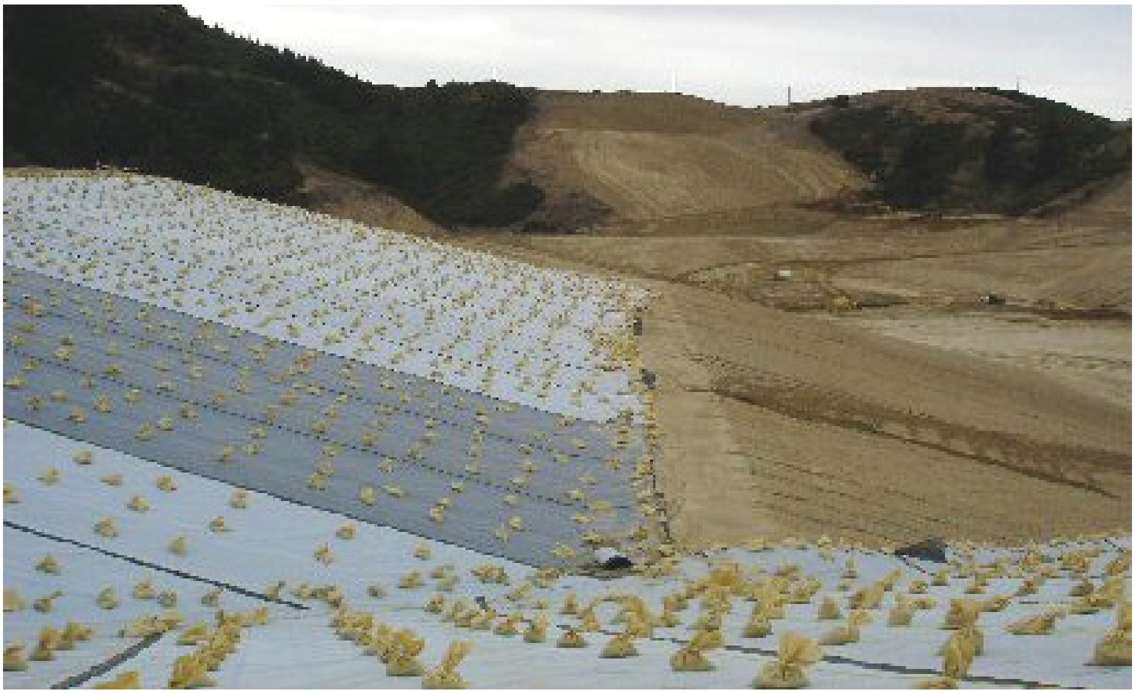


Figure 5 The Regional Landfill at Kate Valley Prior to Becoming Operational in 2005 (Hurunui District Council, 2006a).

The landfill site pictured above in Figure 5 prior to becoming operational in 2005, the liner is used to contain the waste, reduce ground water contamination and collect leachard.

This new landfill is regarded as a “Municipal Waste” landfill, which means it will accept normal household and commercial waste. This type of landfill is also referred to as a “non-hazardous waste” landfill, the same waste that went into the unlined Burwood Landfill for the last sixteen years will go into Kate Valley

3.3 Legal Process

3.3.1 Introduction

This section will look at the planning for a new Canterbury Regional Landfill, resource consent and New Zealand’s legal environment

3.3.2 Consent Process for Kate Valley

Planning for the new Canterbury Regional Landfill at Kate Valley began in 1996. The project received its final resource consent from the Environment Court in March 2003 (CCC, 2004b) with the landfill opening in July 2005.

3.3.3 New Zealand Legal Environment

In New Zealand, waste management is principally a local government responsibility. A number of different statutes set local government responsibilities for waste management:

- **Resource Management Act 1991** – (RMA) Sustainable management of resources and it requires that developments avoid, remedy, and mitigate impacts on the environment; establishes a framework for resource consents for air, land and water discharges. The focus of the RMA is about the environmental effects of waste rather than regulating how waste activities are carried out. Specifically, regional councils are given responsibility to manage the effects of discharges from waste disposal activities.

- **Local Government Act 2002 & (1974)** – encourages sustainable development and requires councils to "promote the social, economic, environmental, and cultural well-being of communities, in the present and for the future” (triple bottom line)

- **Local Government Amendment Act 1996** – requires local authorities to produce waste management plans that focus on the waste hierarchy (i.e. reduce, reuse, recycling, recovery and residual) however it does not provide clear roles and responsibilities for central, regional and local levels with regard to waste minimisation and the roles of the private sector in waste management.

- **Health Act 1956** – promotes and conserves public health and secures the abatement of any nuisance or removal of any condition likely to be injurious or offensive to health. Council statutory obligations for the collection and disposal of refuse arise from the Health Act.

- **Hazardous Substances and New Organisms Act 1996** – The Hazardous Substances and New Organisms Act was enacted in 1996. It is a key part of the legislative architecture to improve the management of waste in New Zealand. The purpose of this statute is to protect the environment, and the health and safety of people and communities by preventing or managing the adverse effects of hazardous substances and new organisms. The importance of this Act to waste management relates primarily to the formal controls it brings to the introduction of new hazardous materials and the handling and disposal of waste hazardous substances.

- **Other legislation** — A range of statutes cover the management of the small volumes of infectious, radioactive and hazardous wastes in New Zealand. These include the Health Act 1956, the Radiation Protection Act 1965, the Agricultural Compounds and Veterinary Medicines Act 1997 and the Ozone Layer Protection Act 1996. In addition, the Building Code (issued under the Building Act) and requirements of the Health and Safety in Employment Act 1992 provide for the safe storage and management of hazardous substances. The Land Transport Act 1998, Maritime Transport Act 1994 and the Civil Aviation Act 1990 all control the transportation of dangerous goods (including categories of hazardous wastes).

All domestic legislation listed above relating to waste management is in accordance with New Zealand's commitments under relevant international agreements listed below (MOE, 2006).

- The Stockholm Convention (Pops, 2006)
- The Waigani Convention in 1995 (ERMANZ, 2006)
- The Basel Convention in 1989 (ERMANZ, 2006)
- The Rotterdam Convention in 1998 (ERMANZ, 2006)

3.3.4 Resource Management Outcome

The Resource Consent application to the Environment Court to operate the landfill was granted in March 2004 with restrictions being placed on the project based on:

- Findings on environmental issues
- The needs of the community
- Responsibilities of the operating company to meet certain guidelines on operation of the landfill and monitoring of impacts
    - Management
    - Design and construction
    - Operation
    - Maintenance
    - Monitoring and contingency
    - Aftercare

A fifty page document listing consent conditions and restrictions was produced, an overview is listed below in Table 8.

	Environment Court Decision Conditions of Consent (Outline)
A) Management:	
	Land ownership
	Operational responsibilities
	The management structure
	Staffing including the use of contractors
	Land ownership / management
	Health and safety procedures
	Community involvement including details of complaints procedures
B) Design and Construction	
	Site access
	Waste haul vehicles accessing the site - comply with the following standards
	1 Euro III Vehicle Emission Standard EU Directive 1999/96/EC
	2 European Truck Noise Standard EU Directive 96/20/EC
	Fencing and security
	Earthworks & Liner Construction
	Stormwater and silt control
	Leachate collection and treatment
	Landfill gas collection and treatment
	Onsite roading / Restoration and Landscaping
	Site amenities & infrastructure including water & power reticulation
C) Operation	
	Management of site users including traffic management
	Waste Acceptance Criteria and procedures
	Placing of refuse and daily cover
	Leachate management
	Landfill gas management
	Nuisance control
	Site security
	Facilities maintenance including weed and pest management
	Incident Contingency Plans for transportation of waste and leachate
D) Maintenance	
	Leachate collection system:
	Landfill gas collection system
	Leachate storage tanks
E) Monitoring & Contingency	
	Groundwater / Surface Water / Site Capping / Leachate
	Landfill & Nuisance Control
	Gas
F) Aftercare:	
	Capping / Weed and Revegetation / Pest control
	Operation and maintenance of leachate management systems
	Operation and maintenance of landfill gas management systems
	Ongoing monitoring of Groundwater / Surface Water / Site Capping
	Ongoing monitoring of Landfill gas and aftercare

Table 8 Environment Court Decision Conditions of Consent Outline (CCC, 2006b).

4 SOLID WASTE QUANTITIES

4.1 Introduction

This chapter looks at the current solid waste quantities in comparison to past quantities. It tries to assess conservative predictions of solid waste transported to Kate Valley in the future. This includes solid waste figures by both CCC for Christchurch and Transwaste Ltd for Canterbury and estimates of waste figures by the author.

4.2 Solid Waste per Capita and Day

4.2.1 Introduction

This section uses a per person and per day figure to benchmark solid waste weight amount (kilos) per annum from 1994 to 2005 and future waste predictions.

4.2.2 Current Waste Stream Quantities

The statistics of the solid waste weight quantities per person and per day shows a reduction of solid waste for the Christchurch population from 1996 onwards with the introduction of kerbside recycling with a negative trend from 2002 / 03 onwards.

The solid waste produced by the Christchurch population shown in Table 9 was approximately 2.25 kilos per person per day in 1994. This figure dropped to a low of 1.81 kilos per person per day in 2000 and 2001. Since then it has increased each year until 2004 to reach 2.1 kilos / person and day. Projections for 2005 show this figure has increased to 2.41 kg per person per and day.

Year	Population	Christchurch Waste Quantity	Kg / per Person / per Day
1994	302,800	249,139	**2.25**
1995	308,800	240,777	**2.14**
1996	317,500	273,000	**2.36**
1997	321,000	233,392	**1.99**
1998	323,000	228,582	**1.94**
1999	324,300	230,822	**1.95**
2000	325,400	227,423	**1.91**
2001	327,200	215,910	**1.81**
2002	332,000	219,872	**1.81**
2003	338,800	229,981	**1.86**
2004	344,100	264,477	**2.11**
2005	345,857	304148	**2.41**

Table 9 Christchurch Solid Waste per kg / per Person / per Day (CCC, 2005c) (Author, 2005)

Table 9 shows that the population has increased by 8.9% in the past ten years, while waste quantities have risen by 11.4%. However the waste quantity per person and day has increased by 2%.

4.2.3 Future Waste Predictions

With a population growth and a continued economic boom, CCC, Meta NZ Ltd, CWS and Transwaste Ltd need to review their current waste management processes to identify areas where further waste reduction amounts can be achieved.

Significant waste reductions could be achieved from the commercial waste stream from businesses as this area has not been fully developed. TerraNova has made inroads by setting up a waste exchange program but this area requires further investigation outside of this research project.

Possible solid waste initiative programs:

- Promoting recycling to businesses
- Expanding and streamlining the current waste exchange program
- Providing waste / recycling education to businesses.

Legislation, educational programmes and possible increases to the cost of disposing of solid waste to landfills could encourage a further minimisation of solid waste. With a greater move to recycling resources more viable markets need to be identified for these products both in New Zealand and overseas.

Failure to do so creates the real possibility of recycled materials ending up in landfills

Depending on the economic outlook in a thriving economy, the amount of waste is often correlated to the economy. Therefore the amount of waste may continue to increase if the economy continues positive growth (immigration, population drift and housing boom)

It is reasonable with the targets set by the CCC, that a prediction of 2 kilos per person is achievable, however it may take some time happen. The current educational program with school children in Christchurch focusing on recycling may no see results for ten years but it is a move for the positive.

4.2.4 Solid Waste in Christchurch

Table 10 below shows the total waste sent to landfill including CCC black rubbish bags in column C, the percentage increase or decrease from the previous year in column D. The waste from other local authorities (LA) is in column E. The balance is green waste / kerbside recycling and the amount of hardfill in columns G, H and I. The last column of figure is the population of Christchurch for the corresponding year.

Year A	Rubbish Bags B	Total CCC Waste Including Bags [t] C	Change [%] D	Other LA* Waste [t] E	Total Refuse sent to Landfill [t] F	Green Waste [t] G	Waste Recycled at Kerbside [t] H	Hardfill and Rubble [t] I	Chch Population J
1994	38,242	249,139	-3.40%	0	**249,139**	2,640	0	29,823	302,800
1995	37,450	240,777	-2.30%	0	**240,777**	12,842	0	32,209	308,800
1996	38,707	235,376	-2.30%	0	**235,376**	22,331	0	33,448	317,500
1997	40,049	233,392	-1.00%	1,693	**235,086**	29,318	1,456	28,134	321,000
1998	38,258	228,582	-3.10%	8,096	**236,677**	27,536	11,856	19,263	323,000
1999	38,325	230,822	1.00%	13,084	**243,907**	32,909	13,219	17,104	324,300
2000	38,320	227,423	-2.50%	14,990	**242,413**	34,503	14,374	14,067	325,400
2001	37,485	215,910	-5.10%	19,254	**235,164**	30,538	15,686	13,438	327,200
2002	36,903	219,872	1.80%	21,349	**241,221**	34,320	17,251	19,797	332,000
2003	35,878	229,981	4.50%	30,857	**260,838**	35,179	20,885	14,670	338,800
2004	34,189	264,477	14.90%	36,001	**290,478**	31,074	24,044	10,577	344,100

Table 10 Actual Christchurch Solid Waste Quantities Sent to Landfill, (CCC, 2005d).

* Other Local Authorities (LA).
Table 11 below shows the seven councils located around Christchurch in the Canterbury region that provides waste data to the Christchurch Waste Subcommittee.

Councils	
Waimakariri District Council	Banks Peninsula District Council
Hurunui District Council	Kaikoura District Council
Selwyn District Council	Christchurch City Council
Ashburton District Council	

Table 11 List of Councils who Provide Waste Data (CCC, 2005f).

4.3 Solid Waste Predictions

4.3.1 Introduction

This section will look at the CCC and Transwaste's projected waste figures from 2004 through to 2015. Estimates of the quantities by the author are based on previous, current and projected trends in population.

4.3.2 Prediction of Waste by Christchurch City Council

Table 12 below shows the ten year trend from 1994 and 2004. In 2004 solid waste was predicted to reduce by one point one percent continuing until 2012, then two point one percent until 2015. The actual figure increased by fifteen percent from 2004 / 2005 to 304,148 tonnes.

Predictions are the population of Christchurch will grow two point five percent to 354,642 in 2010 with solid waste reducing by five point four percent to 287,783. In 2015 the predicted population will continued to growth at two point five percent to 363,360 with the solid waste reducing at .eight percent

Year A	Rubbish Bags B	Total CCC Waste Including Bags [t] C	Change [%] D	Other LA* Waste [t] E	Total Refuse Sent to Landfill [t] F	Green Waste [t] G	Kerbside Recycling [t] H	Hardfill and Rubble [t] I	Chch Population J
1994	38,242	249,139	-3.40%	0	249,139	2,640	0	29,823	302,800
:	:	:	:	:	:	:	:	:	:
2005	**39,488**	**304,148**	**15.50%**	**40,501**	**384,137**	**35,890**	**27,777**	**16,394**	**345,857**
:	:	:	:	:	:	:	:	:	:
2010		287,783	0.057						354,642
:	:	:	:	:	:	:	:	:	:
2015		**265,000**							**363,360**

Table 12 Predicted Christchurch Solid Waste Quantities to Kate Valley Landfill (CCC, 2005f).

Table 13 below shows the total predicted Christchurch solid waste sent to landfill divided by the predicted Christchurch population, multiplied by three hundred and sixty five days to obtain the per kilo / per person and per day figure for each year.

Year	2005	2010	2015	2020
Population	345,857	354,642	363,360	372,123
Christchurch Waste Quantity [t]	304,148	287,783	264,123	246,469
Kg / per person and per day	**2.41**	**2.22**	**2.00**	**1.815**

Table 13 Predicted Solid Waste per Kg / per Person / per Day (Author, 2005).

4.3.3 Prediction of Waste by Transwaste Ltd

In 2003 Transwaste predicted that the upper bound waste increase would be point seven percent per year in the next year and one point one percent for the lower bound per year from 2004 to 2012 as shown in Table 12 below.

The predictions are based on the years 2002 / 2003, however Transwaste could not have foreseen the housing and economic boom in both Christchurch and Canterbury

Table 14 shows a five years projected waste quantity abstracted from thirty five years (Note the predicted opening date of Kate Valley was 2004).

Landfill Year	Assumed Year	Upper Bound [t]	Lower Bound [t]	Most Likely [t] Upper Bound	Most Likely [t] Lower Bound
		0.68% / year	1.1% / year	0.5% / Year	1.1% / Year
1	2004	240,000	220,000	240,000	220,000
2	2005	241,632	217,580	238,800	217,580
:	:	:	:	:	:
9	2012	253,053	201,369	230,566	201,369
:	:	:	:	:	:
25	2028	279,160	N/A	212,797	168,707
:	:	:	:	:	:
35	2038	295,477	N/A	202,393	151,042

Table 14 Predicted Waste Quantities to Kate Valley Landfill (Transwaste, 2002).

4.4 Solid Waste in Canterbury

From historical figures provided in Transwaste's Resource Consent Application in 2003, the population to predicted solid waste figure was set at:

- 1.56 kg per person and day to landfill lower bound
- 1.95 kg per person and day to landfill upper bound (Transwaste, 2002)

The estimated solid waste quantity disposed of in 2004 was predicted to be 240,000 tonnes for Canterbury. The actual figure published for 2004 was 295,000 tonnes, an increase of 55,000 tonnes or 23 percent above the upper-bound prediction.

Figure 6 below was published on the CCC website in 2005 as part of a media release by Transwaste which indicates an actual volume of 2.1 kilos of solid waste per person per day is an increase of 0.70 kilos on the projected figure of 1.4 kilos (Transwaste, 2002).

At the time the figures were projected in 2002, no allowance was made for an 8.9% growth in the population of Christchurch or Canterbury.

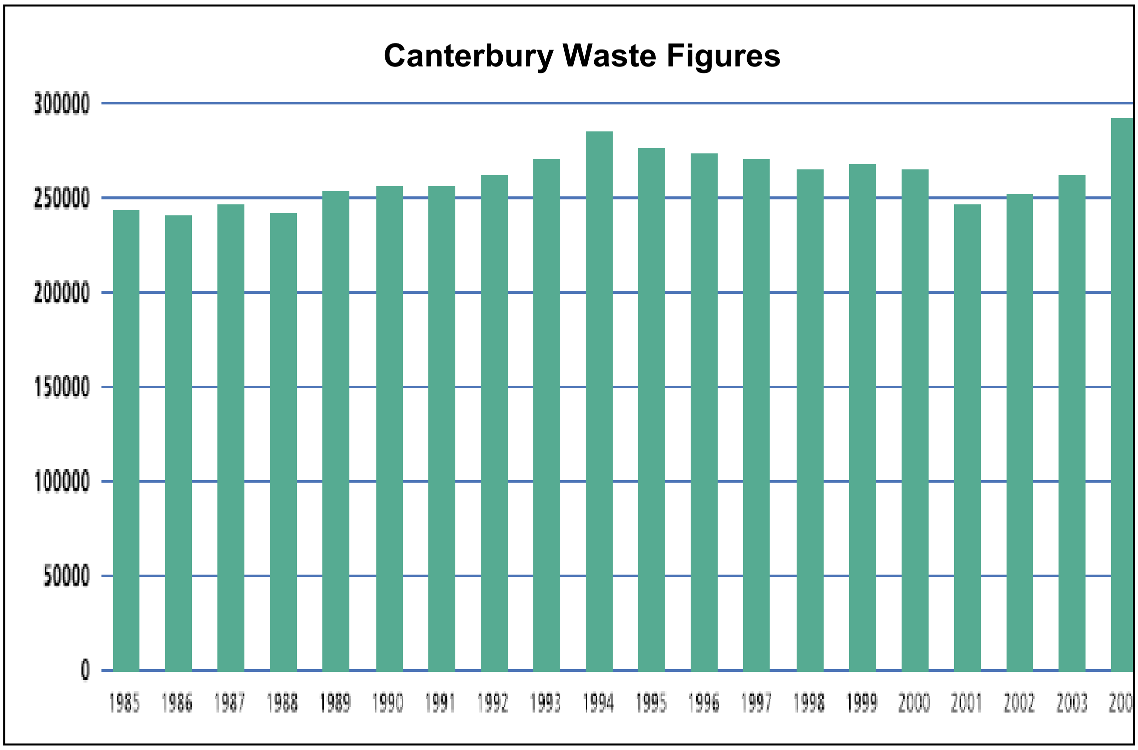


Figure 6 Solid Waste Sent to Landfill in Canterbury (Transwaste, 2005).

The 295,000 tonnes of solid waste shown in Figure 6 is 55,000 tonnes above the upper bound figure projected by Transwaste in its Resource Consent Application and 75,000 tonnes above the lower bound figure (Transwaste, 2003).

4.5 Estimation of Waste Quantities

Analysis of the figures produced by the CCC and Transwaste may be slightly different to the figure identified by the author, however in order to proceed with the comparison between road and rail options, it is important to identify a relevant figure that is reasonable.

The comparison between road and rail will look at the actual 2005 / 2006 data of 304,148 tonnes and the prediction for 2015 estimated to be 265,000 tonnes of solid waste per year.

4.5.1 Estimation of Waste Quantities by Author

The figures below in Table 15 for 2004 / 2005 are the actual solid waste quantities landfilled which were provided by the CCC (CCC 2005i). The quantity of solid waste sent to landfill for 2010 and 2015 are the author's estimations.

The per kilo per person per day in Table 15 shows that prior to the introduction of recycling in early 2001 / 2002 the amount of waste per person sent to landfill was lower than the amount for 2005 and the projected amount for 2010.

Year	Christchurch Waste Amount [t]	Christchurch Population	Christchurch Waste per kg / person / per Day
1995	240,777	308,800	2.14 kg
:	:	:	:
1999	243,907	324,300	2.06 kg
:	:	:	:
2004	264,477	344,100	2.11 kg
2005	**304,148**	345,857	2.41 kg
:	:	:	:
2010	288,000	354,642	2.20 kg
:	:	:	:
2015	**265,000**	363,360	2.00 kg

Table 15 Estimated Waste Quantities per Kilo / per person per Day (Author Prediction, 2005).

The Ministry for the Environment's Solid Waste Analysis Protocol (SWAP) classification system estimated that the quantity of solid waste sent to landfill in New Zealand in 2004 was equivalent to 2.09 kg per person per day (Ministry of Environment, 2006).

5 ROAD TRANSPORT

5.1 Introduction

The transport operation to move the solid waste from the three Christchurch Transfer Stations to the Kate Valley Landfill is the main topic of this chapter. Also considered are the truck and trailer units used and the vehicle specifications, Canterbury's transport volume predictions and the number of truck and trailer return trips to and from Kate Valley.

5.2 Transport Operations

The present transport operation uses:

- Three Mercedes trucks operated by META, one based at each transfer station. Each truck is fitted with a hydraulic operated hook and arm* used to move the waste containers.
- Twelve long haul Mercedes truck and trailer units operated by CWS, fitted with the hook and arm* are used to move the waste containers to the Kate Valley Landfill site and return.
- Four Mercedes trucks operated by CWS fitted with hook and arm* are based at the Kate Valley Landfill to transport the waste containers from the container park on to the landfill.

* The hook and arm operational system (refer appendix 14).

5.2.1 Truck and Trailer Units

The CWS fleet of trucks are maintained to a high standard with regular programmed maintenance undertaken by South Star Freightliners Limited the Mercedes agents in Christchurch, with the trucks travelling over 150,000 kilometres per annum.

The Mercedes truck and trailer units used to transport the waste to Kate Valley must comply with the heavy vehicle weight regulations set out by Land Transport New Zealand (LTNZ).

These regulations currently allow a maximum gross weight of 44 tonnes for a standard truck and trailer configuration being used by CWS in Figure 7 below and must meet Euro 3 emission standards.

Figure 7 Truck & Trailer Unit With Containers Used to Transport Waste from the Transfer Stations to Kate Valley (Canterbury Too Good 2 Waste, 2006a).

Dedicated trucks used by CWS to carry the solid waste containers from the container park at Kate Valley on to the landfill site shown below in Figure 8 do not usually operate outside of the landfill. This system is employed to eliminate contamination from the landfill site to areas outside of the landfill operation.

Figure 8 Specialist Trucks Deliver Waste on to the Landfill Footprint from the Container Park at Kate Valley (Canterbury Too Good 2 Waste, 2006b).

All heavy vehicles accessing the Kate Valley Landfill site must comply with the Euro Three (Euro III) emission standards set out in the resource consent. Currently Euro Five emission standards are in place in some European countries.

The solid waste sent to Kate Valley from the three transfer stations is based on a population of 363,360 in Christchurch (CCC, 2004d) (see Table 16) and a waste quantity of 264,477 tonnes in 2004 / 2005 which equates to a quantity per capita of two kilos per day per person.

Transfer Stations	Waste Quantity [%]	Waste Quantity per Year [tonne]		
		2004 / 2005 [t]	2005 / 2006 [t]	Prediction for 2015 [t]
Parkhouse	45%	119,015	136,867	119,250
Metro	33%	87,277	100,369	87,450
Styx Mill	22%	58,185	66,913	58,300
	100%	**264,477**	**304,148**	**265,000**

Table 16 A Breakdown of Waste Collections for 2004 / 2005, 2005 / 2006 and Predictions for 2015 (CCC, 2005g).

5.3 Truck and Trailer Specifications

5.3.1 Introduction

This section will consider the current truck, trailer and container specifications including payloads, compacted closed containers and non compacted open top containers, maximum payload allowances and the hydraulic operated hook and arm lifting system.

5.3.2 Truck, Trailer and Container Specifications and Payload

The current situation is that a variety of different CWS truck and trailer units and container combinations show differences in the tare weight's, which can vary by up to 300 kilos as shown below in Table 17. This makes the loading of the container critical to achieve the allowed gross weight of 44 tonnes.

Truck & Trailer Specifications	Minimum Payload [t]	Maximum Payload [t]	Variation [t]
Truck (tare)	12.8	12.7	120 kg
Trailer (tare)	4.6	4	
Containers (2)	6.6	6.6	
Total Empty Weight (tare)	24	23.3	700 kg
Allowed Gross Weight	44	44	
Solid Waste Payload Total	**20**	**20.7**	**700 kg**
Maximum Overloading Allowance [t]	**1.5**	**1.5**	

Table 17 Solid Waste Weight Variations Trucked to Kate Valley (META, 2005)

*Includes a 1.5 tonnes Overloading Allowance by Land Transport New Zealand (LTNZ).

5.3.2.1 Compacted Closed Containers

The closed containers used in the present road operation into which solid waste is compacted are transported by road on truck and trailer units to Kate Valley. They carry a payload of 20.4 tonnes and are manufactured from 3mm steel plate, having a double action rear door. The containers have the following specifications listed below in Table 18.

Compacted Closed Containers

Containers	Closed Container [m3]	Waste Payload [t]	Empty Weight [t]
Truck	33.9	8.2	3.2
Trailer	39.7	12.2	3.4
	73.6	**20.4**	

Table 18 Compacted Closed Containers Specifications (Author, 2006).

The open top containers are an alternative option to the closed containers, the solid waste is non-compacted and a mesh cover is used to contain the solid waste. They will be constructed from light steel plate and carry a payload of approximately 22.4 tonnes. These containers have the following specifications listed below in Table 19.

5.3.2.2 Non Compacted Open Top Containers

Containers	Closed Container [m3]	Waste Payload [t]	Empty Weight [t]
Truck	33.9	9.9	2.2
Trailer	39.7	12.5	2.4
	73.6	**22.4**	

Table 19 Compacted Closed Containers Specifications (Author, 2006).

5.3.3 Maximum Payload Allowance

The different tare weights of the truck and trailer units combined with the variable weights of the two different sized containers mean that the maximum solid waste quantity able to be carried per trip to Kate Valley is in the range of 20.0 tonnes to 20.7 tonnes. By using the 1.5 tonnes tolerance the payload figures above (20.0 tonnes and 20.7 tonnes) the maximum payload can be seen as 21.5 tonnes to 22.2 tonnes.

The Commercial Vehicle Investigation Unit (CVIU) based at the Glasnevin weigh bridge confirmed that the CWS truck and trailer units are generally speaking 45 tonnes and thus 500 kg under the tolerated limit of 45.5 tonnes. This is an excellent outcome and shows that good management practise can be achieved (Thull, 2006e).

By taking a median payload figure for closed containers of 20.4 tonnes and an additional 1 tonne (1.5 tonnes being the legal overweight allowance), the figure of 21.4 tonnes will also be used in the following calculations, which is close to the current practice.

A proposal to use open top containers to transport waste to Kate Valley, which are one tonne lighter than the closed containers, a figure of 22.4 tonnes and an additional 1 tonne (1.5 tonnes being the legal overweight allowance) and a figure of 23.4 tonnes will be used in the following calculations. These proposed figures are based on the increase container capacity as a result of higher sides on the open top containers.

5.3.4 Hydraulic Hook and Arm Lifting System

The trucks used to transport waste containers to Kate Valley have had a hydraulic operated hook and arm system fitted to the chassis enabling them to load and unload containers at the Transfer Stations and at Kate Valley shown below in Figure 9 (refer appendix 14).

The containers are able to be moved on the ground with small steel wheels attached to the underside of the containers at the rear. The lifting capacity of the hydraulic arm is 20 tonnes.

Figure 9 CWS Truck Unloading a 7.4m Trailer Waste Container at Kate Valley (Hurunui District Council 2006b).

5.4 Canterbury Traffic Volume Predictions

As a region, Canterbury has an estimated population of 512,600 (Statistics New Zealand, 2006), have a number of physical constraints with mountains to the west and hills to the north. Internal freight transport costs in Canterbury are high as there are few backload opportunities for further cost recovery.

The Canterbury region is well served by a network of State Highways and arterial roads shown below in Figure10 that provide links to the rail network within the region. Most roads provide a good level of accessibility within urban and suburban areas. A motorway services the traffic north from Christchurch to the north end of Kaiapoi and all roads in the region are maintained to a high standard.

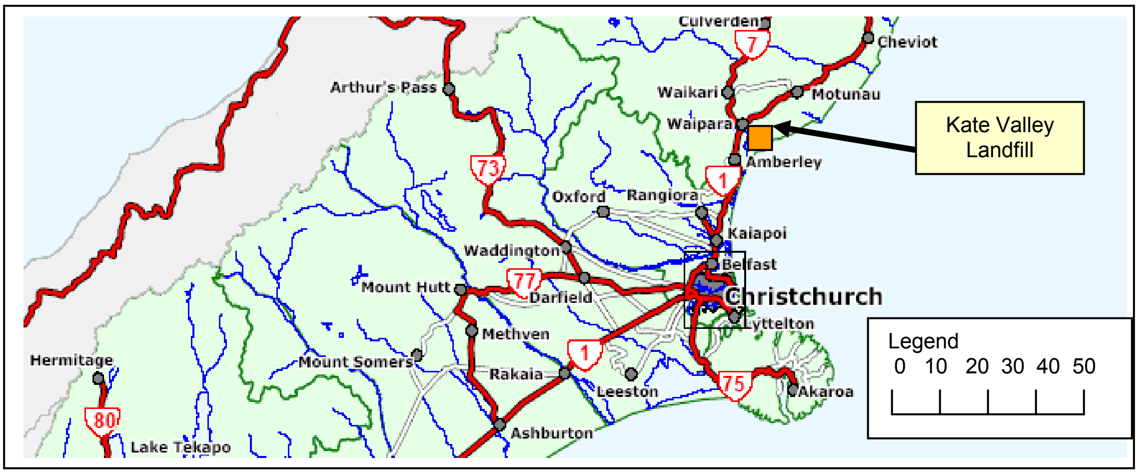


Figure 10 Canterbury Road Network (Transit NZ, 2006b).

Commuter and general commercial traffic volumes in Canterbury are projected to grow by around two percent (compound) per year over the next twenty years. There is growth potential for both road and rail transport.
.
A significantly higher growth rate than two percent per year is projected for heavy freight traffic. Opus International Consultants Limited (Opus) forecast that the number of freight trips in Canterbury (excluding Christchurch) will increase by one hundred and seventy percent over the next twenty years, or approximately five percent (compound) per year (refer appendix 16).

Opus estimates that seventy two percent of the increase in heavy freight traffic will originate in the South Canterbury region, as a result of the expansion of dairy and irrigated arable farming in the area. Twenty eight percent will originate in North Canterbury due to growth in wine production and the waste transport to Kate Valley (ECAN, 2005).

5.5 Return Trips to Kate Valley

5.5.1 Introduction

This section will look at the current road transport routes used by CWS truck and trailer units, the number of return trips to Kate Valley in 2005 / 2006 year and predicted return trips in 2015.

5.5.2 Current Road Transport Routes

The CWS truck and trailer unit's travel from each of the three transfer stations to the nearest ring road effectively by-passing the congestion of the central city as shown in Table 20 and Figure 11 below.

Some drivers do not use the exact route shown but the distance is the same. The routes shown are from each transfer station to the beginning of the northern motorway (SH1) at Belfast.

The route from Belfast to Kate Valley via the northern motorway on SH1 is fifty five kilometres to the intersection of SH1 and SH7. From there it is an additional nine kilometres on the Mt Cass Road to reach the Kate Valley Landfill site.

Transfer Station	Route	Part A	Distance [km]	Part B	Distance [km]	Part C	Distance [km]	Total Km
Parkhouse	Route 1	Parkhouse Rd to Avonhead Rd, Johns Rd to Belfast SH1	19.0	Belfast SH1 to SH74 / SH1 Junction	55	SH1/ SH7 Junction via Mt Cass Rd to Kate Valley	9	83*
Metro	Route 2	Dyers Pass Rd to QEII Dr / Marshlands Rd / to Belfast SH1	17.0					81*
Styx Mill	Route 3	Main North Rd / to Belfast SH1	4.1					68*

Table 20 Distances and Route From Each Transfer Station to Kate Valley Used by CWS Trucks (Author, 2005).

- The trip kilometre figures from each transfer station to the Kate Valley Landfill site are those of the author and may vary from other sources..

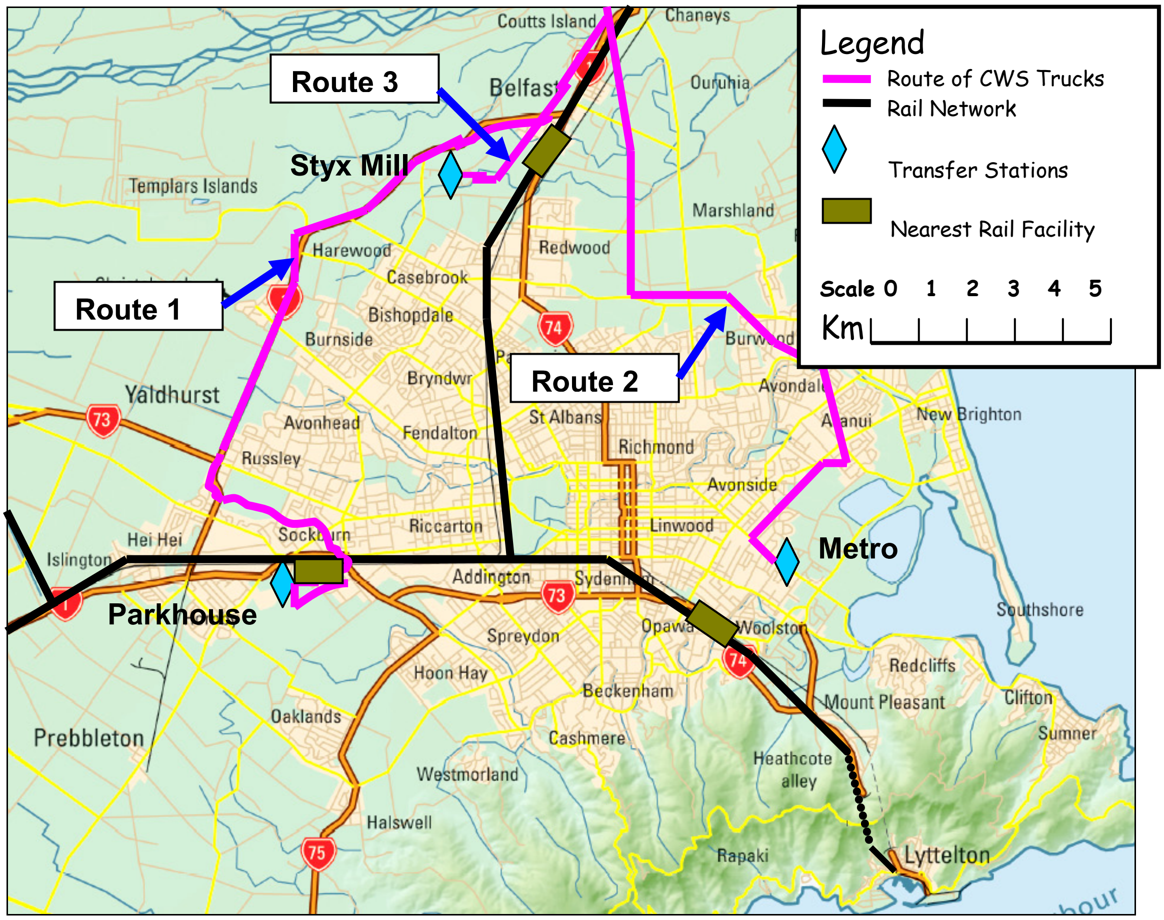


Figure 11 Map of Christchurch Indicating Which Transport Routes is Used by CWS (Selection, 2005).

5.5.3 Return Trips in 2006

The return trip from the transfer stations to Kate Valley is based on an average three hour trip turn around time to travel the approximately one hundred and forty kilometre trip. This includes both picking up of the full container and dropping off of the empty container.

Table 21 below shows the current transfer stations hours of operation and the solid waste amount of 304,148 tonnes. Included are the number of truck and trailer trips to Kate Valley per week and per annum using closed containers and a payload of 20.4 tonnes and 21.4 tonnes.

2005 /2006 Closed Containers

Transfer Station	Hours Open	Waste [%]	2005 /2006 Waste [t]	Trips per annum at 20.4[t]	Trips per Week at 20.4[t]	Trips per annum at 21.4[t]	Trips per Week at 21.4[t]
Parkhouse	13.5	45%	136,867	6,709	129	6,396	123
Metro	13.5	33%	100,369	4,920	95	4,690	90
Styx Mill	11	22%	66,913	3,280	63	3,127	60
	Total	**100%**	**304,148**	**14,909**	**287**	**14,213**	**273**

Table 21 Number of Return Trips to Kate Valley for 2005 / 2006 (Author, 2006).

By increasing the closed container payload from 20.4 tonnes and 21.4 tonnes (see Table 22) the saving in the number of trips to Kate Valley is 696 per annum. By taking an average of the three trips (A, B C from Table 23 of 77 kilometres) the saving is 107,184 kilometres.

The amount of solid waste sent to Kate Valley in the year 2005 / 2006 by using open top containers is 304,148 tonnes per annum based using open top containers and a payload of 22.4 tonnes and 23.4 tonnes as shown below in Table 22.

2005 /2006 Open Top Containers

Transfer Station	Hours Open	Waste [%]	2005 /2006 Waste [t]	Trips per annum at 22.4[t]	Trips per Week at 20.4[t]	Trips per annum at 23.4[t]	Trips per Week at 21.4[t]
Parkhouse	13.5	45%	136,867	6,110	118	5,849	112
Metro	13.5	33%	100,369	4,481	86	4,289	82
Styx Mill	11	22%	66,912	2,987	57	2,860	55
	Total	**100%**	**304,148**	**13,578**	**261**	**12,998**	**250**

Table 22 Number of Return Trips to Kate Valley for 2005 / 2006 (Author, 2006).

Using the lower payload of each container type a comparison using the 20.4 tonne payload for closed container trips and 22.4 tonne payload for open top container trips a the saving is 1331 trips or 204,974 kilometres per annum can be achieved.

5.5.4 Predicted Return Trips in 2015

The amount of solid waste sent to Kate Valley in the year 2015 by using closed containers is predicted to be 265,000 tonnes as shown below in Table 23.

2015 Closed Containers

Transfer Station	Hours Open	Waste [%]	2005 / 2006 Waste [t]	Trips per annum at 20.4[t]	Trips per Week at 20.4[t]	Trips per annum at 21.4[t]	Trips per Week at 21.4[t]
Parkhouse	13.5	45%	119,250	5,846	112	5,572	107
Metro	13.5	33%	87,450	4,287	82	4,086	79
Styx Mill	11	22%	58,300	2,858	55	2,724	52
Total		**100%**	**265,000**	**12,991**	**249**	**12,383**	**238**

Table 23 Number of Predicted Trips to Kate Valley for Year 2015 using 20.4 tonnes and 21.4 tonnes (Author, 2006).

Table 24 below shows the current transfer stations hours of operation. The predicted waste volume of 304,148 tonnes of solid waste sent to land fill in 2005 / 2006. The number of truck and trailer trips to Kate Valley per week and per annum based using open top containers and a payload of 22.4 tonnes and 23.4 tonnes.

2015 Open Top Containers

Transfer Station	Hours Open	Waste [%]	2005 / 2006 Waste [t]	Trips per annum at 22.4[t]	Trips per Week at 22.4[t]	Trips per annum at 23.4[t]	Trips per Week at 23.4[t]
Parkhouse	13.5	45%	119,250	**5,324**	102	5,096	98
Metro	13.5	33%	87,450	**3,904**	75	3,737	72
Styx Mill	11	22%	58,300	**2,603**	50	2,491	48
Total		**100%**	**265,000**	**11,830**	227	11,325	218

Table 24 Number of Predicted Trips to Kate Valley for Year 2015 (Author, 2006).

Note As there is little or no benefit in using the higher payload figure of 21.4 and 23.4 tonnes, I intend to use 20.4 tonnes as the payload figure for closed containers and 22.4 tonnes for the open top containers.

5.6 Advantages and Disadvantages of Using Road Transport

5.6.1 Introduction

The advantages and disadvantages of using road transport will be considered in this section.

5.6.2 Advantages and Disadvantages of Road Transport

Using road transport offers the following advantages and disadvantages shown in Table 25 below:

Road Transport	
Advantages	**Disadvantages**
Fast and effective - moving waste to Kate	Increased traffic congestion to local
Valley	communities
No build up of solid waste at the transfer	Increased noise and emissions in local
stations	communities
Offers flexibility in deliveries to Kate Valley	Increased fuel costs and road user charges
No double handing from transfer station to	Road safety issues on route and SH1
Kate Valley	and SH7 intersection
3 hour turnaround	Damage to road surface

Table 25 Advantages and disadvantages of Road Transport (Author, 2006).

6 RAIL TRANSPORT

6.1 Introduction

From a triple bottom line point of view, it is timely to assess rail transport systems to move solid waste to the Kate Valley Landfill from the present road transport operation used by CWS.

This chapter will look at an alternative rail transport (intermodal) operation from the three Christchurch Transfer Stations. Also it will look at a road / rail operation, other proposed waste by rail operations, truck and trailer use, train operation from Christchurch to Glasnevin. The rail container operations at Glasnevin and road transport to Kate Valley and the advantages and disadvantages of using a road / rail system.

6.2 Rail Use in Canterbury

The main trunk line is well served by the current rail freight network that provides links to the north and south of the region and the Midland line connects Canterbury with the West Coast as shown below in Figure 12.

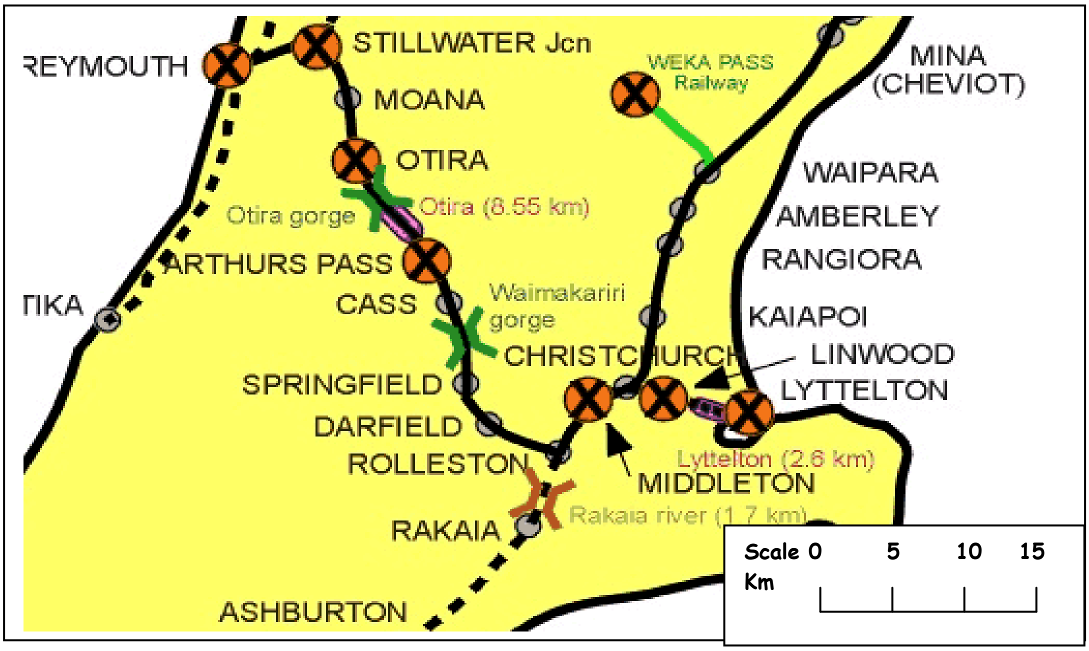


Figure 12 Map of the Canterbury Rail Network (Steam, 2006).

The two main rail lines intersect at Rolleston, approximately twenty five kilometres south-west of Christchurch. There are also several small branch lines, including an important link through to the port of Lyttelton (via Christchurch). Although the rail system has been built to a high standard, it is not being used to its full potential (ECAN, 2005).

Approximately 4.2 million tonnes of freight per year is carried by rail in Canterbury. The Christchurch North line carries some 1.4 million tonnes of freight per year. Of this, approximately 45% is through-freight, travelling between the lower part of the South Island and the North Island. The remaining 55% of freight travels between Christchurch and the north (ECAN, 2005).

6.3 Road / Rail Option

6.3.1 Introduction

This section endeavours to outline and describe the “waste by rail” operation proposed and other “waste by rail” operations overseas.

6.3.2 Description of Operation

It is important to mention that the rail option (see Figure 13) will be of three intermodal movements combining:

- **Road 1** Road transport of the full waste containers from the transfer station to the nearest rail facility in Christchurch
- **Rail** By train (flat deck wagon) the waste containers are transported from a rail facility in Christchurch to Glasnevin
- **Road 2** Road transport of the waste containers from Glasnevin to the Kate Valley Landfill

This option involves additional handling of the waste containers over the present system.

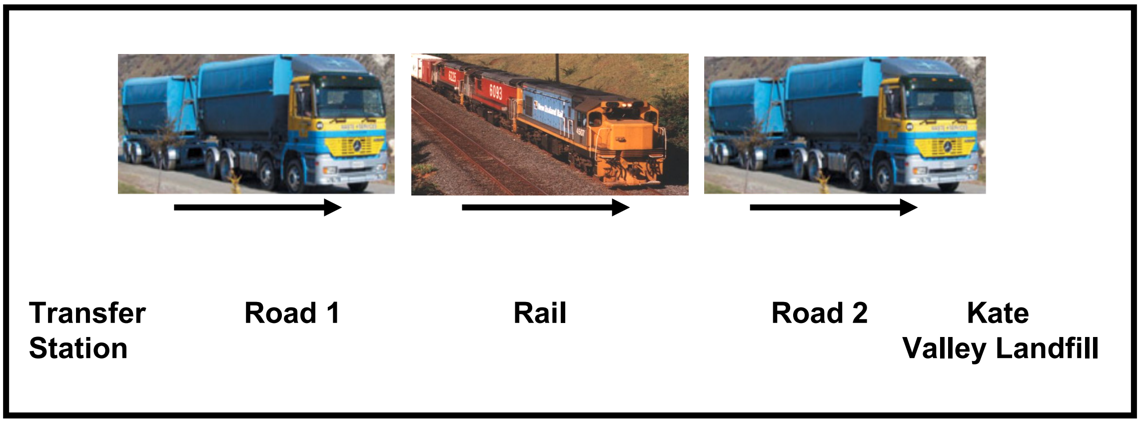


Figure 13 Rail Option to Transport Solid Waste to Kate Valley (Author, 2006).

6.3.3 Other Proposed Waste by Rail Operations

In Los Angeles County, California on the West Coast of the United States, currently the totally of all solid waste is transported to disposal sites in the metropolitan area by truck. As public opposition to new or expanding existing disposal facilities near urban areas has grown an alternative option of “Waste by Rail” is being considered.

Refuse trucks deliver solid waste to the materials recovery facilities (MRFs) or transfer stations located throughout Los Angeles County where the waste is processed for the recovery of recyclable materials and inspected for the presence of hazardous waste or other unacceptable materials.

The residual solid waste would be loaded into rail-ready shipping containers, which would be delivered to a local rail loading facility by truck where the containers would be loaded onto rail wagons. Empty containers would be removed from the rail wagons and loaded onto trucks to be transported back to the materials recovery facilities (MRFs) or transfer stations.

Within California, there are two landfills that are designed and permitted to receive waste via rail: the Mesquite Regional Landfill in Imperial County and the Eagle Mountain Landfill in Riverside County. In August 2000, the Sanitation Districts entered into purchase agreements for both of these sites. Both sites are located approximately 200 miles east of Los Angeles along the Union Pacific Railroad. The containers would be transported to one of these landfills where the waste would be unloaded and disposed of (LACSD, 2006).

As landfills are closed the need to " export" waste to other states is increasing, information obtained from the Solid Waste Association of North America shows that publicly and privately owned landfills capable of receiving waste by rail are operating, planned, or under construction in Utah, Idaho, California, and elsewhere in eastern Washington (Metrokc, 2006).

6.4 Transport Operation from the Three Transfer Stations

6.4.1 Introduction

This section will consider the proposed transport operation from the three transfer stations to the nearest rail facility and the transport hours of operation. Also discussed is the proposed operation from the three rail facilities. This includes the number and type of rail locomotives and rail wagons required to transport both closed and open top containers to Glasnevin. Also considered is the trucking of the waste containers from Glasnevin to Kate Valley and the possible regional rail transport option.

6.4.2 Transport Operating Hours

The three transfer stations are restricted to the transport operating hours listed below in Table 26.

Transfer Station	Hours of Operation			Additional Restrictions
	Open	Close	Hours	
Parkhouse	5.30am	6.00pm	12.5	None
Metro	5.30am	6.00pm	12.5	None
Styx Mill	7.30am	6.00pm	10.5	Floor must be emptied every night

Table 26 Restricted transport operating hours for each transfer station (Author, 2006).

6.4.3 Proposed Operation

The existing hook truck at each transfer station would continue to be used to move the containers from beneath the floor of the transfer station to the container park. One of the CWS long haul truck and trailer units would be used at each transfer station to transport the full containers (two at a time) to the nearest rail facility.

At the rail facility the containers will be loaded on to flat deck rail wagons and transported to Glasnevin eleven kilometres south west of Kate Valley. From Glasnevin the containers would be transported by road to Kate Valley Landfill site using one of three CWS truck and trailer units.

The containers would be emptied and returned to the rail wagons at Glasnevin to await transport back to the rail facilities in Christchurch and finally returned to one of the three Christchurch Transfer Stations to be refilled.
In Table 27 and Figure 14 below the distances from:

- The Christchurch Transfer Stations to the nearest rail facility
- From the rail facility to Glasnevin
- From Glasnevin to Kate Valley

Transfer Station	Rail Access	Alternative Rail Access	Location Point of Access	Rail Yard Distance [km]	Distance to Glasnevin [km]	Glasnevin to Kate Valley [km]	Feasibility
Parkhouse	No	Yes	Middleton	1.2*	76	11	Yes
Metro	No	Yes	Woolston	4.4	79	11	Yes
Styx Mill	No	Yes	Belfast	1.3	58	11	Yes

Table 27 Distances from each Transfer Station to Kate Valley Using a Road / Rail Combination (Author, 2006**).**

- In June 2002, land adjacent to Parkhouse was purchased by the CCC (refer Appendix 10) to provide potential rail access and additional space for future solid waste minimisation activities. A rail siding runs from Middleton into the area behind Parkhouse, this could be activated reducing the distance to the rail facility to nil (CCC, 2002).

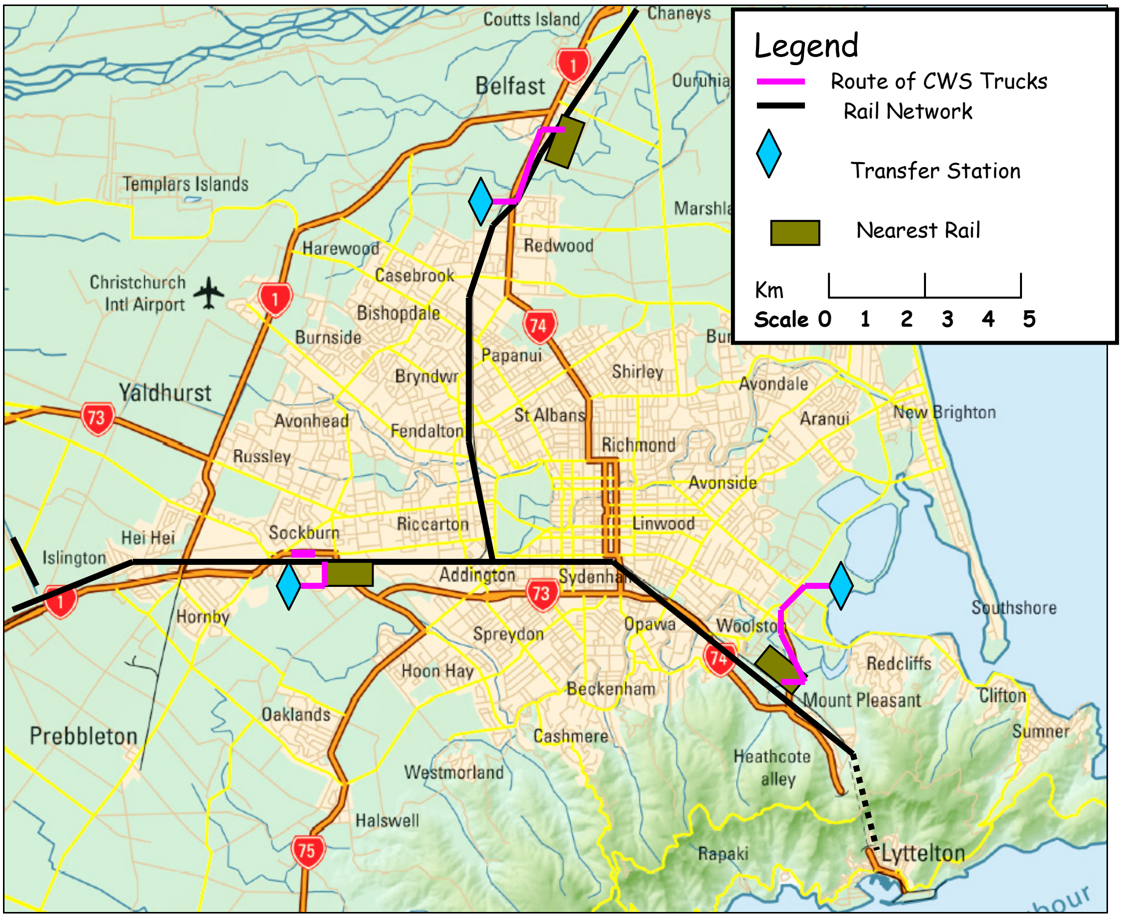


Figure 14 Locations of the 3 Transfer Stations and the Nearest Rail Facility (Selection, 2005).

6.4.4 Location of Rail Facility to Each Transfer Station

Table 28 below shows the nearest rail facility to each transfer station. In the case of both Parkhouse** and Styx Mill a rail siding would need to be constructed.

**Depending on the access to the existing rail siding at Middleton.

Transfer Station	Location	Nearest Rail Facility	Suburb	Distance [km]
Parkhouse	Parkhouse Rd	Curletts Rd Over bridge	Middleton	1.2**
Metro	Metro Rd of Dyers Rd	Cunmore Tce / Tanners Rd	Woolston	5.5
Styx Mill	Styx Mill Road	Radcliffe Rd	Northwood	2

Table 28 Distance from each transfer station to the nearest rail facility (Author, 2006).

6.4.5 Rail Operation Christchurch to Glasnevin

On a daily basis the rail wagons would be taken from both the Parkhouse Road and Woolston rail facilities to the rail shunting yards near Addington where a train would be made up during the night. It would then travel to Northwood and collect the additional wagons from the Styx Mill and leave in the early hours of the morning to travel to Glasnevin.

The train would consist of either a combination of two locomotives or a single locomotive depending on the number of wagons to go to Kate Valley. Two locomotives (DFT and DX combination) are able to operate with up to 50 wagons per trip (100 containers) however, the number of wagons is limited by three factors:

- The pulling power of the locomotive combination
- The rail line weight rating (tonne)
- The incline of the rail line (slippage / traction)

Because of the rail line rating shown below in Table 29, the Christchurch to Picton line which passes Glasnevin is limited to a total weight limit by different locomotive combinations. Excess wagons would be collected and held at the Addington rail yards for the next available waste train going to Glasnevin.

		Locomotive Combinations	**Locomotive Combinations**	**Single Locomotive**
		DFT / DX	**DQ / DFT**	**DX**
Christchurch to Glasnevin	Rail Line Rating (tonne)	1,950	1,850	1,140
Glasnevin to Christchurch	Rail Line Rating (tonne)	2,100	1,980	1,190

Table 29 Rail Line Rating for Different Locomotive Combinations from Christchurch to Glasnevin and Return (Toll, 2006a).

6.4.6 Locomotives and Rail Wagons

The locomotives and rolling stock in New Zealand are operated by Toll Rail which is a division of Toll Holdings, the rail network is owned by the New Zealand Railways Corporation (NZRC) and since July 2004 has trading as Ontrack (Wikipedia, 2006e).

The locomotives used between Christchurch and Picton listed in Table 30 below are used in different combinations to achieve the “best fit” for the rail line weight rating and the number of wagons to be moved.

Locomotive Class	**Power Output (Pull)[kw]**	**Weight [t]**	**Operates**	**Top Speed [km/h]**	**Length [m]**	**Number in Service**
DFT	1230	86	All of New Zealand Rail Network	113	16.7	
DFT(Upgraded)	1800	86	All of New Zealand Rail Network	113	16.7	29
DX	2050	97.5	All of New Zealand Rail Network	120	17.9	
DXR	2240	105	All of New Zealand Rail Network	120	17.9	46
DQ	3780	110	From Otiria to Bluff	80	16.3	3

Table 30 Locomotives Used on the Christchurch to Picton Rail Line (Wikipedia, 2006g).

*__Note__ The DX locomotive was upgraded to the DXR and some were modified, the main purpose of these modifications was to enable the class to be used on the

Midland line between Lyttelton and Greymouth in the South Island; particularly in the difficult 8.5km Otira to Arthur's Pass tunnel section (Wikipedia, 2006a).

Pictured below in Figure 15 are the four main types of locomotives used on the main rail line between Christchurch and Picton*.

DXR Locomotive

DFT Locomotive

DQ Locomotive

DX Locomotive

Figure 15 Pictures of the Locomotives used between Christchurch and Picton (J Christianson, Wikipedia, 2006c).

There are seven classes (see table 31) of flat deck rail wagons used by Toll Rail in New Zealand, of these classes, four are able to carry the solid waste containers. The other three classes are not suitable due to their container configuration or weight for this project.

Wagon Class	Maximum Speed [km]	Tare Weight [kg]	Maximum Axle Load [[t]]	Total Weight [kg]	TEU's *	Fitted to Carry 3.05m Boxes
HK, HKP	100	15,000	16	50,000	2.5	Yes 2 containers
IA, IAS	80	16,000	18	56,000	2.5	Yes 2 containers
IB, IBS	80	15,550	18	56,450	3	No 2 containers
IC	80	16,000	18	56,000	3	No 2 containers
PK	80	13,100	14	44,000	2	Yes 2 containers
UK, UKA	80	14,300	14	43,000	2.5	Yes 2 containers
USQ	80	13,000	14	41,000	2	No 2 containers

Table 31 Flat Deck Rail Wagon Axle Weights (Toll Rail, 2006c) (K Lee, 2006).

*(TEU) Twenty-foot equivalent units is a measure of containerised cargo capacity equal to 6.10 m (length) × 2.44 m (width) × 2.59 m (height), or approximately 39 m^3 (Wikipedia, 2006d).

For this research project I have used the one most suitable class of flat deck rail wagon the UK / UKA class to transport containers of solid waste from Christchurch to Glasnevin.

Table 32 below shows the two different amounts of solid waste using closed containers and Table 33 using the proposed open top containers.

Closed Containers

Wagon Class	Solid Waste [t]	Truck Container [t]	Trailer Container [t]	Rail Wagon Tare Weight [t]	Total Weight [t]	Maximum Allowable Weight [t]	Variance +/- [t]
UK, UKA	20.4	3.2	3.4	14.3	41.3	43.0	-1.7
UK, UKA	21.4	3.2	3.4	14.3	42.3	43..0	-0.7

Table 32 Comparison of Closed Containers and Rail Wagons to Maximum Allowable Weight [tonne] (Author, 2006).

Open Top Containers

Wagon Class	Solid Waste [t]	Truck Container [t]	Trailer Container [t]	Rail Wagon Tare Weight [t]	Total Weight [t]	Maximum Allowable Weight [t]	Variance +/- [t]
UK, UKA	22.4	2.2	2.2	14.3	41.1	43.0	-3.9
UK, UKA	23.4	2.2	2.2	14.3	42.1	43.0	-2.9

Table 33 Comparison of Open Top Containers and Rail Wagons to Maximum Allowable Weight [tonne] (Author, 2006).

By using the UK / UKA class of flat deck wagon and a combination of different locomotives shown below in Table 34, the maximum numbers of containers able to be transported per trip is one hundred using the combination of the DX and DFT locomotives, however the most efficient use of a locomotive is using one DX as it is able to take up to sixty containers per trip.

		Weight [t]		**Weight [t]**		**Weight [t]**
Locomotive Type	DX	97.5	DQ	110	DX	97.5
	DFT	86.0	DF	86.0		
Locomotives Combined Weight		183.5		196.0		97.5
Rail Line Rating ([t])		1950		1850		1140
Difference between Locomotive Weight & Rail Line Rating		1766.5		1654.0		1042.5
Wagon Class and Total Weight	UK, UKA	34.7	UK, UKA	34.7	UK, UKA	34.7
Maximum Number of Wagons per Train		**50**		**47**		**30**
Maximum Number of Containers Train		**100**		**94**		**60**

Table 34 The Number of Wagons and Containers per Locomotive Combination (Author, 2006).

6.4.7 Road Transport from Glasnevin to Kate Valley

At Glasnevin land would need to be purchased to build a rail / containers handling facility. This would be used to store the wagons / containers while awaiting transport to

Kate Valley. The area would need to be fenced, bunded (raised earth mounds) and landscaped to screen the facility from State Highway 1 and the surrounding area.

The containers will be unloaded from the rail wagons and transported the final ten kilometres to Kate Valley using the CWS truck and trailer units. At Kate Valley the containers would be unloaded and left in the container park to be emptied on to the landfill.

Empty containers would be loaded on to the truck and trailer units and returned to Glasnevin where they would be loaded on to the rail wagons for the return trip to Christchurch.

6.4.8 Possible Regional Future Rail Transport Option

The proposed rail scenario put forward for transporting Christchurch's solid waste maybe able to be duplicated by other councils in Canterbury to take advantage of the rail system to transport their solid waste to Kate Valley. This would mean up to three or four trains per day could possibly be required. However, this research project is limited to the three Christchurch Transfer Station's, no other areas of the Canterbury region have been included in this research.

6.5 Loading and Unloading Systems

6.5.1 Introduction

This section will look at a small number of transport systems that maybe useful to consider for future waste transport operations and will develop a comparison between these systems. It will also identify the different loading / unloading systems for both road and rail transport.

6.5.2 Systems

There are several different options of loading and unloading systems available:

- The hook and arm system currently used by CWS (refer appendix 14)
- Horizontal transhipment using the Cargo Domino system used in Switzerland (refer appendix 15)
- Roll-on / Roll-off technology using the ACTS system used in Europe.

<u>Note</u> The Roadrailer System (Triple Crown, 2006) and a Container Swing Lift System (Steelbro, 2006) are both feasible options but they have not been considered as part of this study (see Figure 16).

Figure 16 The Roadrailer System (Triple Crown, 2006) and Swinglift (Steelbro, 2006).

6.5.3 Cargo Domino System

Cargo Domino is a transport system developed in Switzerland by SBB Cargo Ltd in 1998. It uses the principles of combining road and rail container transport with interchangeable containers without the need to trans-ship goods. The system has seven movements as shown below in Figure 17 and Figure 18.

Shown below in Figure 18 are photos of the Cargo Domino System in operation in Switzerland (SSB, 2006). This system is able to be used in either a horizontal or vertical movement.

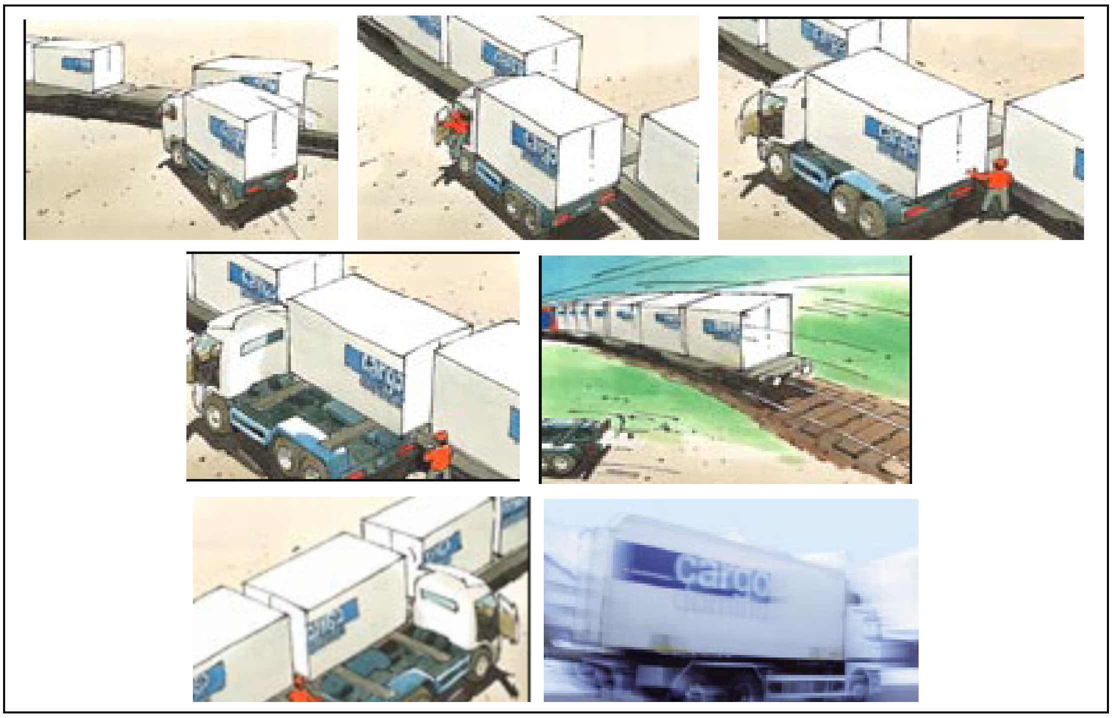


Figure 17 The Seven Movements of the Intermodal Cargo Domino System (SBB Cargo 2005a).

The systems intermodal movements are:

- The supplier loads the container at their business location
- Transport by road from the supplier to nearest rail point
- Transfer of interchangeable containers from road transport to standard flat rail wagon
- System operates by hydraulic rams
- Containers are able to be moved horizontally and vertically
- Containers are moved by rail
- Transfer of interchangeable containers from rail back to road transport
- Subsequent carriage by road - from rail to the customer

The benefits of using the Cargo Domino system are:

- Use of intermodal transport system based on horizontal transhipment shown below in Figure 16, both horizontal and vertical transhipments are possible
- Cost savings on freight transport of 180,000+ kilometres travelled per annum
- Reducing traffic congestion by up to 1300 return trips per year to Kate Valley
- Reduced emissions (CO_2, carbon monoxide)
- Improved safety (less accidents)
- Reduced staff numbers required (transport operation can be handled by 8 staff)
- The cost to adapt the existing CWS trucks to handle the Cargo Domino system is low
- Possible reduction in on-going maintenance costs of components
- Able to use the same system to transport leachard to Bromley Waste Water facility in Christchurch (saving additional truck return trips from Kate Valley

Figure 18 The Cargo Domino System in Operation in Switzerland (SBB Cargo, 2005b).

Martin Ruesch from Switzerland published a case study in June 2003 on intermodal freight strategies including comparisons between Cargo Domino and ACTS container transfer systems.

6.5.4 A.C.T.S. System

The ACTS system is widely used in Switzerland to ship waste, which is a simple horizontal load transfer system from vehicle to rail without fixed terminal installations. The transfer of containers from road to rail relies on a turntable system mounted on special flat deck rail wagons shown in Figure 19 below.

The transfer of containers from road to rail offers the following benefits:

- It is simple and can be operated by the road vehicle driver
- Fast transfer (less than 5 minutes from truck to rail wagon)
- No additional equipment required
- Secure locking system ensures the safety of containers during rail transit
- Able to use the existing CWS truck hook lift system

The cost of the ACTS system is high as the system requires specific rail wagons to be equipped with specially designed turntables. The existing CWS truck and trailer units would be able to operate this system using their hook and arm systems to transfer containers from the turntable wagons to either truck chassis or trailer units

ACTS System (Stift, 2004)

ACTS Rail Wagon (Rail Logistics, 2004)

Hook and Arm Truck (Telepresents, 2006)

ACTS System in Operation (Wikipedia, 2006b)

Figure 19 Images of the A.C.T.S. Rail / Road Transfer System.

6.5.5 The Modalohr System

The Modalohr system uses a lowered-deck articulated rail wagon to carry road vehicles (truck and trailer units) equipped with standard wheels as shown below in Figure 20.

Figure 20 The Modalohr system in use transporting road truck and trailer units by rail (Modalohr, 2006)

Although this system has benefits where it operates in both France and Italy in alpine areas, the cost to set up specialised loading and unloading terminals in both

Christchurch and at Glasnevin combined with the short distances of the solid waste operation for Christchurch would prove it to uneconomic to operate.

There would be no cost reduction in truck and trailer unit numbers, staff costs or operational costs using this system. It would require additional staff to load and unload the vehicles on to the wagons in both Christchurch or Glasnevin and tie up the truck and trailer units.

6.5.6 Crane and Forklift

The overhead gantry crane is used in all types of container handling facilities worldwide. At Glasnevin this would be effective due to the limited area. Only one loading / unloading lane would be required as shown in Figure 21 (refer appendix 7).

An additional staff member would be required to load and unload the containers with specialised training to operate the equipment.

All personnel that operate a gantry must have had the appropriate training and be certified to operate the equipment, while employees required to operate forklifts must hold an “F” endorsement on their valid New Zealand driver license (Forklifts, 2006).

Figure 21 Overhead Gantry Crane Operation (OPC Tudelft, 2006) and Container Forklift (Fork Lift Action, 2006).

6.6 Advantages and Disadvantages of a Road / Rail Transport System

6.6.1 Introduction

This section will look at the comparison of using a road / rail transport system.

6.6.2 Comparison of Using a Road / Rail System

A comparison of using a combination road / rail / road system offers the following advantages and disadvantages below in Table 35.

Road / Rail System	
Advantages	**Disadvantages**
Cost effective	Double handling of containers
Reduced emissions	Time taken to tranship containers
Improved safety	Cost of building a rail facilities
Fuel savings and Road User Charges (RUC)	Altering closed containers to fit rail wagons
Reduced operational costs	
Reduced staff costs	
Reduced impacts on local communities	

Table 35 Comparison of the Advantages and Disadvantages of Road / Rail Operation (Author, 2006).

6.6.3 Comparison of the 4 Transfer Systems

The comparison below in Table 36 shows the system types and key issues associated with each system.

Of the four transfer systems proposed only two are compatible with the operation proposed, these are:

- The Cargo Domino Transfer System
- Overhead Gantry / Container Crane Operation

This is due to the limited area of operation at both the rail facilities and at Glasnevin, the need for specialised rail wagons and the costs associated with each system.

System Types	Key Issues
Cargo Domino System	
Road / Rail / Road	Horizontal & Vertical Transhipment of Containers
	Containers Able to Stand Up
	Cost Effective on Short or Long Haul
	Reduced Emissions (CO_2, carbon monoxide)
	Reduced Staff Numbers Required
	Low Maintenance Costs
	Fast Turnaround of Containers
	One Person able to Operate System
	Limited Space Required at Rail Facility or Glasnevin
	Excellent Safety Record
Overhead Gantry Crane / Forklift	
	Fast Turn Around of Containers
	Limited Area Required
	Staff Require Specialised Training
	Additional Staff Required to Operate Equipment
	Specialised Training on Equipment
ACTS System	
Road / Rail	Roll On / Roll Off System
	Intermodal Transport Operation
	Able to Operate on Level Ground (Without a Terminal)
	Requires Specialised Rail Wagons with Turntables
	Able to use Existing Hook/Arm Containers
	Large Amount of Space Required
	Reduced Emissions (CO_2, carbon monoxide)
	High Build and Maintenance Costs
Modalohr System	
Road /Rail	Specialised Terminals
	Construction of Specialised Rail Wagons
	Truck & Trailer Units Travel on Rail Wagons
	High Build Costs
	High Set Up & Operating Cost
	Labour Intensive (19 drivers plus additional rail staff)

Table 36 A Comparison of the 4 Different Transport Systems (Author, 2006).

6.7 Conclusion

After completing a comparison of the different systems in Table 34, the preferred system is the Cargo Domino option however, the current hook and arm system offers significant benefits.

A possible combination of the two systems needs to be assessed in depth to ascertain if it is a viable option, but it is not part of this study.

7 CONTAINER OPERATION

7.1 Introduction

This chapter will examine the current container operation, container management, container numbers required for both a road or rail operation and the operation of both closed and open top containers. Also considered are the specifications of the truck and trailer units and containers, loading options and the future rationalisation of container numbers.

7.2 Container Operations

7.2.1 Introduction

This section will consider the current container operation, the closed containers presently in use and the use of the proposed open top containers.

7.2.2 Current Operation

The transport of solid waste depends largely on specific weight of the transported material. Generally speaking household waste is about one tonne per cubic metre (m^3), which does not require any compaction prior to transportation. The current operation in Christchurch uses basic technology and allows a mix of all waste and does not achieve a high specific weight.

A sample of ten container weights taken on the 12th November 2005 indicated these weights varied from 19.1 to 22.1 tonnes. Only one of the ten sample weights checked exceeded the legal limit.

Figure 22 The two different sized containers used to transport waste (Thull 2005a).

Two different sized containers are used by CWS to transport waste to Kate Valley from the transfer stations as shown above in Figure 22

- The truck containers used are 6.4 m long
- The trailer containers are 7.4 m long

The containers used by CWS are manufactured of welded 3 millimetre steel plate, due to the light construction they may not standing up to the loading / compacting of the solid waste or the empting process.

The life expectancy of the containers is between eight and ten years, however with the damage they are being subjected to the predicted life expectancy is believed to be closer to five years (META, 2005).

Figure 23 A Damaged Container at the Metro Transfer Station (Thull, 2005b).

From observations, estimates of up to sixty percent (seventy two containers) of the one hundred and twenty containers in use are already in a damaged condition since the operation started in July 2005.

After consultation with containers manufactures and personal from Meta NZ Ltd suggest that the containers need to be constructed of a minimum of 4 millimetre steel plate to reduce the damage.

Damage to the containers identified in Figure 23 above shows the warping and buckling of the exterior plates, splitting of the welds, punctures of the container around the area of the lifting bar and damage to the underside of the containers.

Damage to the rear door system may cause failure of the door seals which will result in leakage from the container of waste residues.

This is relevant to investment costs of containers as the damaged containers may need to be replaced years earlier than their life expectancy.

7.3 Container Management

7.3.1 Introduction

This section will look at the numbers of containers required to transport solid waste to Kate Valley using a transport model to predict the number of truck and trailer units required to meet the number of return trips per day.

7.3.2 Container Operation

The current system requires empty containers to be available at each transfer station for loading. Once filled they are taken to the container park at each transfer station by a hook and arm truck, which then takes another empty container to the loading area to be filled.

From the transfer station the full containers are taken to Kate Valley by CWS truck and trailer unit where they are unloaded from the truck and trailer units. Empty containers are picked and returned to the transfer stations as shown below in Figure 24 and the cycle begins again.

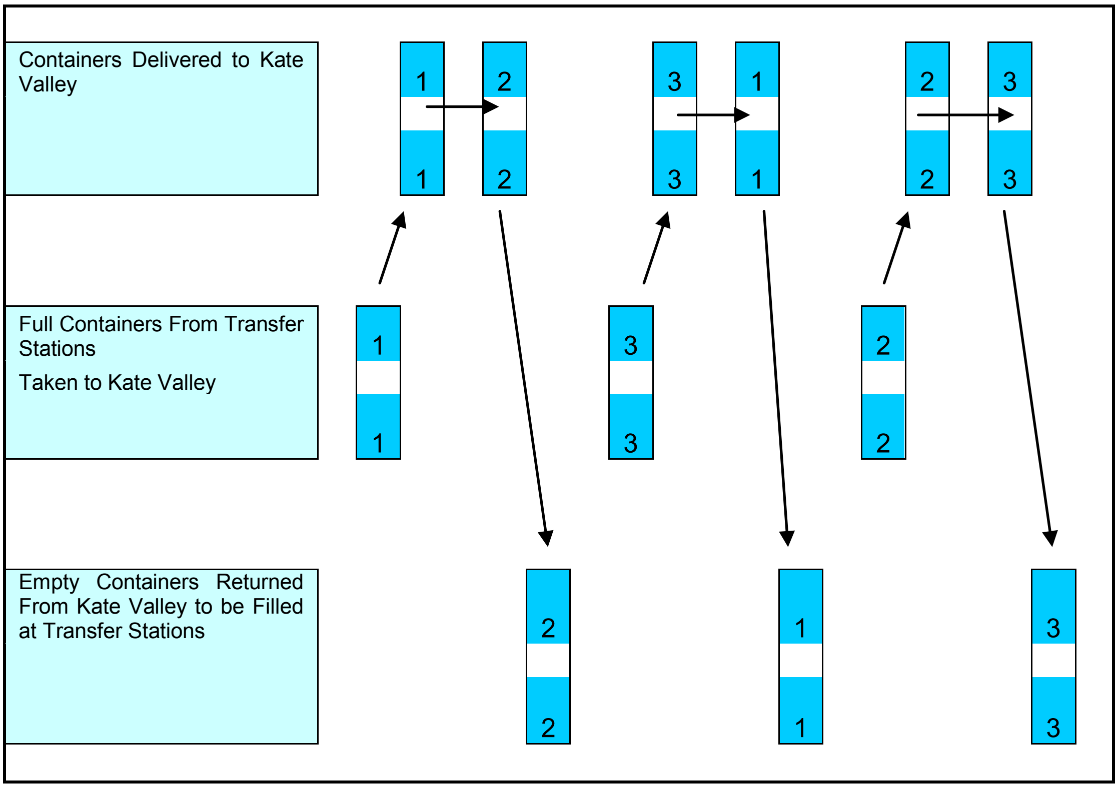


Figure 24 Container Movements from the Transfer Stations to Kate Valley & Return (Author, 2006).

Table 37 is used to identify the number of containers required using the number of truck and trailer units required and the number of return trips to Kate Valley.

	Number of Return Trips to Kate Valley				
Number of Truck & Trailer Units Required per Transfer Station	**1**	**2**	**3**	**4**	**5**
1	4	6	6	6	6
2	8	12	12	12	12
3	12	18	18	18	18
4	16	24	24	24	24
5	20	30	30	30	30
6	24	36	36	36	36
7	28	42	42	42	42

Table 37 The Number of Containers Required for the Transport System Needs (Thull, 2006c).

The full containers left at Kate Valley are then taken by one of the four dedicated hook and arm trucks on to the landfill where they are emptied and dropped back to the container park at Kate Valley to be returned to the transfer stations.

7.4 Number of Container Required for a 6 / 7 Day Operation

7.4.1 Introduction

This section identifies the number of containers required for a number of different scenarios using a six or seven day operation.

7.4.1.1 Container Numbers 6 Day Operation

From the summary below in Table 38 it can be seen that the four trips per day, six days per week operation offers an advantage over the three trips per day operation for each transfer station.

6 Day a Week Operation for 2005

Trips per Day	Parkhouse		Metro		Styx Mill	
	6 Days		6 Days		6 Days	
Payload	**3 Trips per Day**	**4 Trips per Day**	**3 Trips per Day**	**4 Trips per Day**	**3 Trips per Day**	**4 Trips per Day**
Closed Containers						
Total Containers 20.4[t]	**50**	**42**	**36**	**29**	**29**	**22**
Total Containers 21.4[t]	50	36	36	29	22	22
Open Top Containers						
Total Containers 22.4[t]	**50**	**36**	**36**	**29**	**22**	**22**
Total Containers 23.4[t]	43	36	36	29	22	22

Table 38 *2005 Summary of Container Numbers Required for a 6 Day Operation (Author, 2006).

7.4.1.2 Summary 7 Day Operation Container Numbers

Table 39 shows that using a four trip per day, seven day operation offers a reduction in the number of containers required but this need to be weighed against the additional cost to employ a larger driver staff. It also reduces the time for ongoing maintenance of the truck and trailer units.

7 Day a Week Operation for 2005

Trips per Day	Parkhouse		Metro		Styx Mill	
	7 Days		7 Days		7 Days	
Payload	3 Trips per Day	4 Trips per Day	3 Trips per Day	4 Trips per Day	3 Trips per Day	4 Trips per Day
Total Containers 20.4[t]	**43**	**36**	**36**	**29**	**22**	**14**
Total Containers 21.4[t]	43	36	29	29	22	14
Open Top Containers						
Total Containers 22.4[t]	**43**	**29**	**29**	**22**	**22**	**14**
Total Containers 23.4[t]	36	29	29	22	22	14

Table 39 *2005 Summary of Container Numbers Required for a 7 Day Operation (Author, 2006).

<u>*Note</u> For individual trip per day calculations refer to Appendix 10.

7.4.2 Summary of Containers

Table 38 provides the number of containers required for a daily operation in relation to the number of truck and trailer units and the number of return trips to Kate Valley.

The following tables for 2005 show the number of containers required in relation to a summary of closed and open top containers (for a breakdown of the summary tables refer to appendix 10)

By using a seven day operation with four trips per day to Kate Valley it is possible to significantly reduce the number of containers required for the operation, however a more realistic scenario is to use a six day per week operation using open top containers with a 22.4 tonne payload.

7.5 Closed Containers

The existing closed containers in use by CWS have the unloading door at the rear of the container which has two actions.. The first action allows for a bi-fold square door to be opened facilitating loading of the container. The second action allows the whole rear of the container to be swung around to the side of the container for empting as shown below in Figure 25.

Figure 25 Unloading Operation of a Closed Container (B J Scarlett, 2006).

Beneath the transfer station floor the containers are placed on a weighbridge scale and locked to the waste compactor. Solid waste is loaded in the containers using a hydraulic ram, which forces the waste into the containers until the required weight is obtained.

Two different sized solid waste containers are used to transport the solid waste (see Figure 26), the smaller 6.4 metre container is the truck container and the 7.4 metre container fits the trailer unit.

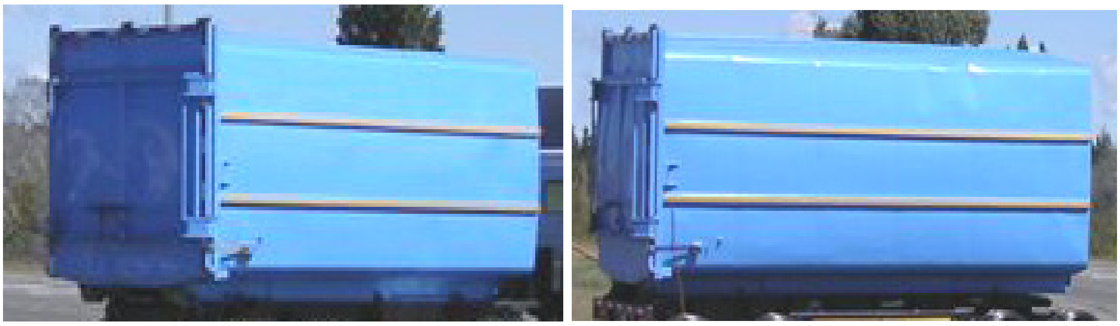


Figure 26 Truck 6.4 m and Trailer 7.4 m Closed Containers Used by CWS (Canterbury Too Good 2 Waste, 2006a).

Table 40 below shows the specifications of the truck and trailer closed containers

Containers	Closed Container [m3]	Internal Dimensions	Waste Payload [t]	Empty Weight [t]
Truck	33.9	5.9 x 2.3 x 2.5	8.2	3.2
Trailer	39.7	6.9 x 2.3 x 2.5	12.2	3.4
	73.6		**20.4**	

Table 40 Specifications of the Closed Truck and Trailer Containers used by CWS (CCC, 2006c).

7.6 Open Top Containers

The proposed open top containers are lighter than the closed containers because the have no roof and are of lighter construction as the waste is not compacted into these containers. The saving in weight of approximately one tonne allows for a higher payload. The open top container is shown below in Figure 27.

Figure 27 The Proposed Open Top Container to Transport Solid Waste (Actsag, 2006) and a Hook and Arm Truck and Container (Hofmanninger, 2004).

Solid waste is often shredded before it is loaded into the open top containers, this means the waste does not require compacting to load the container. Although the open top containers can carry more waste they are not usually loaded to the maximum as the waste may damage the mesh cover used to cover the container and to avoid litter.

After investigation the open top container option, it offers the following benefits over closed containers set out below in Table 41.

Characteristics	Benefits
Higher Payloads / Easy to Unload	Fewer trips to Kate Valley
	Improved fuel economy.
	Fewer containers required.
	Reduction in costs.
	Less container damage.
Non Compressed Waste	Reduction in maintenance.
	Increase container working life.

Table 41 Benefits of Using Open Top Containers (Author, 2006).

Table 42 below shows the specifications of the truck and trailer open top containers, the tare weight (empty weight) of the open top containers reflects that the do not have to have the strength of the compacted closed containers and they have no roof.

The open top containers are one1 tonne lighter that the compacted closed containers of the same size. The sides of the open top containers have been increase to accommodate more solid waste.

Containers	Open Top Container [m3]	Internal Dimensions	Waste Payload [t]	Empty Weight [t]
Truck	38.3	6.4 x 2.3 x 2.7	9.9	2.2
Trailer	38.3	6.4 x 2.3 x 2.7	12.5	2.4
	76.6		**22.4**	

Table 42 Open Top Container Specifications (Author, 2005).

7.7 Container Specifications

7.7.1 Introduction

This section looks at the container specifications and payload of both the closed container and open top container and the possible rationalisation of the containers numbers.

7.7.2 Truck, Trailer and Container Specifications and Payload

The current situation is that a variety of different CWS truck and trailer units and container combinations show differences in the tare weight, these can vary by up to 700 kg as shown in Table 43 below. This makes the loading of the containers critical to achieve the allowed gross weight of 44.0 tonnes.

The closed containers are heavier than the open top containers as they are built to withstand the compaction process and have a solid roof.

From a payload point of view, the open top containers are lighter and the payload can be increased. This would change the payload from approximately 20.0 tonnes and 21.0 tonnes to 22.4 tonnes and 23.4 tonnes.

Truck and Trailer Specifications	Minimum Payload [t]	Maximum Payload [t]	Variation [kg]
Closed Containers			
Truck (tare)	12.8	12.7	120 kg
Truck Closed Container (tare)	3.2	3.2	
Trailer (tare)	4.6	4.0	600 kg
Trailer Closed Container (tare)	3.4	3.4	
Total Empty Weight (tare)	24.0	23.3	700 kg
Allowed Gross Weight	44.0	44.0	
Solid Waste Payload Total	**20.0**	**20.7**	**700 kg**
Maximum Overloading Allowance of 1.5 tonnes	21.5*	22.2*	Max 1.5 [t]
Open Top Containers			
Truck (tare)	12.8	12.7	120 kg
Truck Open Top Container (tare)	2.2	2.2	
Trailer (tare)	4.6	4.0	600 kg
Trailer Open Top Container (tare)	2.4	2.4	
Total Empty Weight (tare)	22.0	21.3	700 kg
Allowed Gross Weight	44.0	44.0	
Solid Waste Payload Total	**22.0**	**22.7**	**700 kg**
Maximum Overloading Allowance of 1.5 tonnes	23.5*	24.2*	Max 1.5 [t]

Table 43 Predicted Solid Waste Weight Variations Using Open Top Containers (Author, 2006).

*Includes 1.5 tonnes + Overloading Allowance by Land Transport New Zealand (LTNZ).

The payload figure used in this study will be 20.4 tonnes for closed containers and 22.4 tonnes for open top containers

7.8 Loading of Containers

7.8.1 Introduction

This section will look at compacting waste versus non compaction, a proposed loading system for open top containers and train logistics from the three Christchurch rail facilities to Glasnevin.

7.8.2 Compacted Verses Non Compacted Solid Waste

The present method of compacting solid waste into the closed containers placed beneath the floor of the transfer station is often ineffective. The compaction of waste into closed containers causes damage to the containers and uneven filling of the containers, leaving pockets of unused space, and can cause problems unloading the solid waste from the containers at the landfill.

Non-compaction of waste into (see Figure 28) containers reduces damage to the containers, increases their life span and reduces cost. The most effective process to maximise that amount of waste loaded in to containers is to shred the waste and use a movable conveyor system to top load a container.

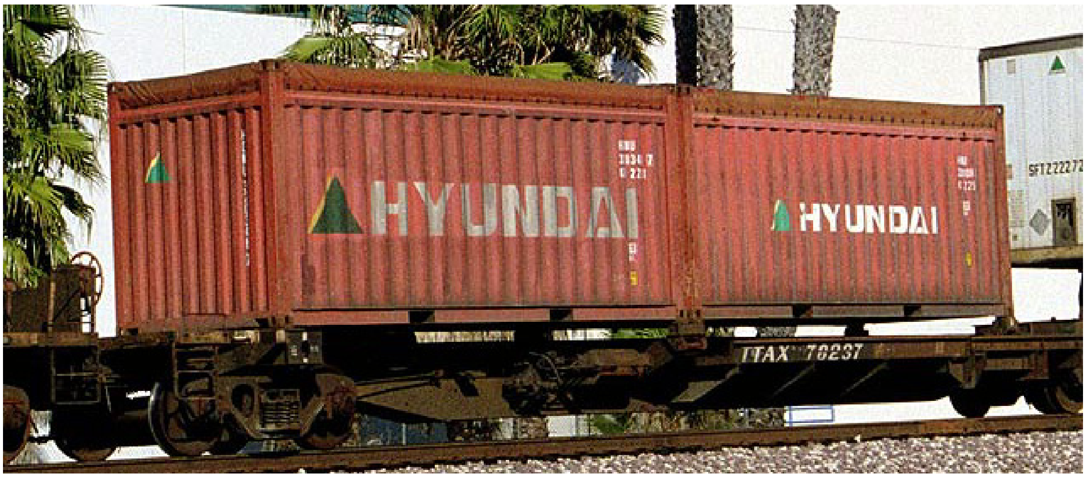


Figure 28 Open Top Containers loaded on a Flat Deck Rail Wagon (Internet Trains, 2006).

7.8.3 Transport from the Transfer Station to Rail

Table 44 below shows the number of containers required with 304,148 tonnes of solid waste, using a 20.4 tonne payload per trip, the time taken to transfer the containers from the transfer station to the nearest rail facility and return with empty containers to the transfer station 6 days per week

<u>Note</u> The times shown below (Table 45) are dependant on the transfer station producing sufficient solid waste to keep the process operating continuously during opening hours.

Transfer Station	Number of Containers	Rail Yard Location	Distance to Each Rail Facility [km]	Transport Time to Rail Facility	Number of Return Trips	Distance Travelled per Day [km]	Total Time
Parkhouse	43	Middleton	1.2	20 min	22	53 km	7 hr 20min
Metro	32	Woolston	4.4	30 min	16	141km	8 hr
Styx Mill	21	Belfast	1.3	20 min	11	29 km	3 hr 40min
Total	96				49*	375 km	19 hr

Table 44 Predicted Times Required to Transport Containers to the Nearest Rail Facility for a 6 Day Operation (Author, 2006).

Note *The floor at Styx Mill Transfer Station must be empty every night

7.9 Advantages and Disadvantages of Container Types

7.9.1 Introduction

The advantages and disadvantages of both the closed containers and the open top containers will be considered in this section.

7.9.2 Advantages and Disadvantages of Using Closed Containers

Table 45 below compares the advantages and disadvantages of using closed containers

Closed Containers	
Advantages	**Disadvantages**
Rear Container Door	Lack of external ribbing to increase strength
Little or no smell	Expensive to build
Compacted waste	High maintenance cost
Reduced litter	Problems removing compacted solid waste
Secure	Door locking system
Easy to move	Weight of the containers

Table 45 Comparison of Closed Containers (Author, 2006).

7.9.3 Advantages and Disadvantages of Using Open Top Containers

Table 46 below compares the advantages and disadvantages of using open top containers

Open Top Containers	
Advantages	**Disadvantages**
Non compacted waste	Increase chance of smell
Reduced damage (no compaction)	Inability to fill to maximum
Possible reduced maintenance costs	Time taken to put on mess cover
Reduced construction costs	Lighter construction
Longer life span	Not as robust as closed containers
Increased waste capacity	Time to secure mesh cover
Reduced weight	Possible problems with rear door system
Waste breaks down quicker in a landfill	Increased height

Table 46 Comparison of Open Top Containers (Author, 2006).

7.9.4 2005 Road Transport Operation

Listed below (see Tables 47 and 48 are examples of the calculations for the number of containers for the proposed rail transport operation, the numbers are based on 304,148 tonnes of solid waste (CCC, 2005). Each transfer station process the following percentage:

Parkhouse	45%	136,867 tonnes of solid waste
Metro	33%	100,369 tonnes of solid waste
Styx Mill	22%	66,912 tonnes of solid waste

The two examples (see Tables 48 and 49 Both tables below use the information from Table 38 to optimise the containers numbers.

An allowance of twenty percent has been made in the calculation for peak periods where the number of containers required increases and ongoing maintenance and repairs of the container fleet.

Road Transport Using 20.4 tonne Payload Closed Containers for 2005

Parkhouse Transfer Station				
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
136,867		**20.4 [t] Payload**		
Return Trips / Week	**7 Day Operation**		**6 Day Operation**	
129	18.4->19		21.5->22	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	6.3	4.8	7.3	5.5
Number of Trucks	**6**	**5**	**7**	**6**
Selected	6 Trucks	5 Trucks	7 Trucks	6 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	**36**	**30**	**42**	**36**
20% allowance	7	6	8	7
Total Containers	**43**	**36**	**50**	**42**

Table 47 The Number of Containers Required for a Road Transport Operation using Closed Containers and a 20.4 tonne Payload (Author, 2006)

Note The number of trucks is rounded either up if under 0.5 it is rounded down or over 0.5 up to the next number. For all of the calculations for each weight and transfer station (refer to appendix 10).

Road Transport Using 22.4 tonne Payload Open Top Containers for 2005

Parkhouse Transfer Station				
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
136,867		**22.4**		
Return Trips / Week	**7 Day Operation**		**6 Day Operation**	
118	16.9->17		19.7->20	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	5.7	4.3	6.7	5
Number of Trucks	**6**	**4**	**7**	**5**
	6 Trucks	5 Trucks	7 Trucks	5 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	**36**	**24**	**42**	**30**
20% Allowance	7	5	8	6
Total Containers	**43**	**29**	**50**	**36**

Table 48 The Number of Containers Required for a Road Transport Operation using Open Top Containers and a 22.4 tonne Payload (Author, 2006)

7.9.5 2005 Rail Transport Operation

Two sets of containers are required for the rail operation, (see Table 49) set A is at the transfer stations in Christchurch being loaded while set B is at Glasnevin being unloaded.

An allowance of 20% has been made in the calculation for peak periods where the number of containers required increases and ongoing repairs of the container fleet.

Rail Transport Using 20.4 tonne Payload Closed Containers for 2005

304,148 [t] per annum 20.4[t] per Truck and Trailer / Trip Closed Containers						
Transfer Station	**Waste / Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	136867	2,632	439	376	43	37
Metro	100369	1,930	322	276	32	27
Styx Mill *	66912	1,287	215	184	21	18
	304148	**5849**	**975**	**836**	**96**	**82**
Number of Rail Wagons					**48**	**41**
20% Container Allowance for Peak Periods & Repairs					**19**	**16**
Numbers of Container Required including 20%					**115**	**98**
Set 2 Total Number of Containers (at Glasnevin)					96	82
Total Container Numbers					211	180

Table 49 Rail Operation (Multimodal) Using a 20.4 tonne Payload, Closed Container (Author, 2006).

Table 50 below uses open top containers with a 22.4 tonne payload also requires two sets of containers for the operation for 2005.

Rail Transport Using 22.4 tonne Payload Open Top Containers for 2005

304,148 [t] per annum 22.4[t] per Truck and Trailer / Trip Open Top Containers						
Transfer Station	**Waste/ Annum [t]**	**Waste / Week[t]**	**Waste / Day 6 Day Operation [t]**	**Waste / Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	136867	2,632	439	376	39	34
Metro	100369	1,930	322	276	29	25
Styx Mill *	66912	1,287	215	184	19	16
	304148	**5849**	**975**	**836**	**87**	**75**
Number of Rail Wagons					**44**	**38**
20% Container Allowance for Peak Periods & Repairs					**17**	**15**
Total Numbers of Container Required					**104**	**90**
Set 2 Total Number of Containers (at Glasnevin)					87	75
Total Container Numbers					191	165

Table 50 Rail Operation (Multimodal) using a 22.4 tonne Payload (Author, 2006).

7.9.6 Projected Road Transport Option for 2015

The same criteria is used for the projected 2015 road option (see Tables 51 and 52 below) except the total projected amount of solid waste is 265,000 tonnes.

Projected 2015 Road Transport Using 20.4 tonne Payload Closed Containers

Parkhouse Transfer Station				
Waste / Annum [t]		**Truck and Trailer / Trip [t]**		
119,250		**20.4 [t] Payload**		
Return Trips / Week	**7 Day Operation**		**6 Day Operation**	
112	16		18.6->19	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	5.3	4	6.3	4.8
Truck Numbers Selected	5	4	6	5
	5 Trucks	4 Trucks	6 Trucks	5 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Number of Containers	**30**	**24**	**36**	**30**
20% allowance	6	5	7	6
Total Containers	36	29	43	36

Table 51 The Number of Containers Required for a Road Transport Operation using Closed Containers and a 20.4 tonne Payload (Author, 2006).

Projected 2015 Road Transport Using 22.4 tonne Payload Open Top Containers

Parkhouse Transfer Station				
Waste / Annum [t]		**Truck and Trailer / Trip [t]**		
119,250		**22.4 [t] Payload**		
Return Trips / Week	**7 Day Operation**		**6 Day Operation**	
102	14.6->15		17	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	5	3.8	5.7	4.3
Truck Numbers Selected	**5**	**4**	**6**	**4**
	5 Trucks	4 Trucks	6 Trucks	4 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Number of Containers	**30**	**24**	**36**	**24**
20% Allowance	6	5	7	6
Total Containers	**36**	**29**	**43**	**30**

Table 52 The Number of Containers Required for a Road Transport Operation using Open Top Containers and a 22.4 tonne Payload (Author, 2006).

7.9.7 Projected 2015 Rail Transport Operation

The same criteria is used for the projected 2015 road option (see Tables 53 and 54 below) except the total projected amount of solid waste is 265,000 tonnes.

Two sets of containers are required for the operation, set A is at the transfer stations in Christchurch being loaded set B is at Glasnevin being unloaded.

Projected 2015 Rail Transport Using 20.4 tonne Payload Closed Containers

265,000 [t] per annum	20.4[t] Payload / Trip				Closed Containers	
Transfer Station	**Waste/ Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	119,250	2,293	382	328	37	32
Metro	87,450	1,682	280	240	27	24
Styx Mill *	58,300	1,121	187	160	18	16
			849	**728**	**83**	**71**
20% Allowance for Peak Periods & Repairs					**17**	**14**
Total Numbers of Container Required					**100**	**85**
Set 2 Total Number of Containers (at Glasnevin)					83	71
Total Container Numbers					183	156

Table 53 Projected 2015 Rail Transport Operation with Closed Containers Using a 20.4 tonne Payload (Author, 2006).

Projected 2015 Rail Transport Using 22.4 tonne Payload Open Top Containers

265,000 [t] per annum	22.4[t] Payload /Trip				Open Top Containers	
Transfer Station	**Waste / Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	119,250	2,293	382	328	34	29
Metro	87,450	1,682	280	240	25	21
Styx Mill *	58,300	1,121	187	160	17	14
			849	**728**	**76**	**65**
20% Allowance for Peak Periods & Repairs					**15**	**13**
Total Numbers of Container Required					**91**	**78**
Set 2 Total Number of Containers (at Glasnevin)					**76**	**65**
Total Container Numbers					**167**	**143**

Table 54 Projected 2015 Rail Transport Operation with Open Top Containers Using a 22.4 tonne Payload (Author, 2006).

8 RETURN TRIPS TO KATE VALLEY

8.1 Introduction

This chapter will consider the number of return trips to Kate Valley for the 2005 / 2006 year and predictions for the 2015 year. It will also look at both a six day and a seven day per week operation.

8.2 Return Trip Numbers to Kate Valley

8.2.1 Introduction

This section will look at the number of containers required to transport the waste to Kate Valley:

- For the current operation in the 2005 / 2006 year based on 304,148 tonnes of solid waste per annum
- For predicted operation in the 2015 year based on 265,000 tonnes of solid waste per annum

2005 /2006 and 2015 will be considered for both a six day and seven day operation per week.

8.2.2 2005 / 2006 7 Day per Week Operation

At present CWS uses approximately one hundred and forty containers to continually process the waste from the three Christchurch Transfer Stations.

The minimum number of containers required for the operation can be calculated based on the quantity of solid waste to be transported to Kate Valley as shown in Table 55 and Table 56 which give a comparison between a seven day a week operation (except the Styx Mill Transfer Station which transports solid waste only six days a week) and a six day a week operation.

The following tables will show two similar scenarios using 20.4 tonnes and 21.4 tonnes payload for the current 2005 / 2006 year using a seven day operation Table 55 and a six day a week operation Table 56

The maximum payload allowance of 21.9 tonnes (including the 1.5 tonnes tolerance allowed by the LTNZ) will not be discussed as a serious business would not base their operation on using maximum legal tolerances.

The 21.4 tonnes will show operational benefits to CWS and its shareholders but the operational planning is not supposed to be based on these figures. The advantages gained for the assumption of 21.4 tonnes compared to the original figures of 20.4 tonnes only contribute to boost business profit and operate within the framework of the resource consent.

2005 / 2006 Seven Day per Week Operation

	Trips / annum	Transport Operation Days of the Week	Operation Days	Return Trips per Day	Truck & Trailer Operating 3 Return Trips	Truck & Trailer Operating 4 Return Trips
20.4 [t]	**304,148 [t] / annum**					
Parkhouse	6,709	7	363	18	6.2->6	4.6->5
Metro	4,920	7	363	14	4.5->5	3.5->4
Styx Mill *	3,280	6	311	11	3.7->4	2.75->3
	14,909		**345#**	**43**	**14****	**11****
21.4 [t]	**304,148 [t] / annum**					
Parkhouse	6,396	7	363	18	6	4.5->5
Metro	4,690	7	363	13	4.3->4	3.3->3
Styx Mill *	3,127	6	311	10	3.3->3	2.5->3
	14,413		**345#**	**42**	**14****	**11****

Table 55 Seven Day Operation, 20.4 tonnes and 21.4 tonnes, Three and Four Trips per Day (Author, 2006).

<u>**Note**</u> * Styx Mill operates seven days a week but only transports waste six days per week

**The number of containers for three return trips per day and four return trips per day requires an additional container as some waste will remain at the transfer station.

8.2.3 2005 / 2006 Six Day per Week Operation

Shown in Table 56 below are two similar scenarios using 20.4 tonnes and 21.4 tonnes payload for the current 2005 / 2006 year using a six day operation.

2005 / 2006 Six Day per Week Operation

	Trips / annum	Transport Operation Days of the Week	Operation Days	Return Trips per Day	Truck & Trailer Operating 3 Return Trips	Truck & Trailer Operating 4 Return Trips
20.4 [t]	**304,148 [t] per annum**					
Parkhouse	6,709	6	311	22	7.3->7	5.5->6
Metro	4,920	6	311	16	5.3->5	4
Styx Mill *	3,280	6	311	11	3.7->4	2.8->3
	14,909			**48**	**16****	**12****
21.4 [t]	**304,148 [t] per annum**					
Parkhouse	6,396	6	311	21	7	5.3->5
Metro	4,690	6	311	15	5	3.8->4
Styx Mill *	3,127	6	311	10	3.4->3	2.5->3
	14,213			**46**	**15****	**12****

Table 56 Six Day Operation, 20.4 tonnes and 21.4 tonnes, Three and Four Trips per Day (Author, 2006).

**** Note** The number of containers for most three return trips per day and four return trips per day requires an additional container as some waste will remain at the transfer station.

8.2.4 2015 Projected Operation

The 2015 solid waste projection made by the CCC is based on a figure of 265,000 tonnes generated within the Christchurch City boundary (CCC, 2005).

The number of truck and trailer units required to move the containers to Kate Valley is shown below in Table 57. It should be noted with two or more trips per day the number of truck and trailer units remains constant up to five trips per day.

2015 Projected Operation Seven Day per Week

	Trips / annum	Transport Operation Days of the Week	Operation Days	Return Trips per Day	Truck & Trailer Operating 3 Return Trips	Truck & Trailer Operating 4 Return Trips
20.4 tonnes	**265,000 [t] / annum**					
Parkhouse	5,846	7	363	16	5.3->5	4
Metro	4,287	7	363	12	4	3
Styx Mill *	2,858	6	311	9	3	2.3->2
	12,990			**38**	**13****	**10****
21.4 tonnes	**265,000 [t] / annum**					
Parkhouse	5,572	7	363	15	5	3.8->4
Metro	4,086	7	363	11	3.7->4	2.8->3
Styx Mill *	2,724	6	311	9	3	2.2->2
	12,383			**36**	**12****	**9****

Table 57 Seven Day Operation, 20.4 tonnes and 21.4 tonnes, Three and Four Trips per Day (Author, 2006).

* Styx Mill operates seven days a week but only transports waste six days per week

The savings between 20.4 tonnes and 21.4 tonnes payload, three and four trips per day equates to a cost saving of one truck and trailer unit.

Taking into consideration that only twelve CWS truck and trailer units are available, it can be assumed that some truck and trailer units must take four return trips per day. Changing the assumption from 20.4 tonnes to 21.4 tonnes payload and three to four return trips per day per truck and trailer unit drops the number of units from thirteen to ten.

This does not allow for much to go wrong and the operation will certainly become more difficult if only a six day operation was allowed through resource consent.

By reducing the number of truck and trailer units available, this would put pressure on the operation and not allow for any breakdowns or unscheduled maintenance.

9 TRIPLE BOTTOM LINE

9.1 Introduction

Concerns for the global environmental, social issues and economic costs are increasingly reflected in the expectations that people have a Triple Bottom Line (TBL) concept expands the range of traditional reporting to include economic, community issues (social) and environmental impacts.

9.2 Impacts on a Triple Bottom Line

In Table 58 below what type of impacts influence the economic, social and the environmental areas and try to understand if they affect more than one element.

	Noise	Vibration	Air Pollution	Road Safety	Fuel Usage	Spills
Economic			X	X	X	
Community Issues	X	X	X	X	X	X
Environmental	X	X	X	X	X	X

Table 58 Impacts on a Triple Bottom Line

9.3 Economics

9.3.1 Introduction

This section will consider from an economic point of view the direct costs to the population of Christchurch for the transport operation and the advantages and disadvantages of using

- The current road transport operation
- The proposed rail (intermodal) operation

Consider the fuel usage based on either a 20.4 tonne or 22.4 tonne payload. Identify which option offers the most benefits, cost reductions to the operation, fuel use and the purchase of land at Glasnevin for a rail / container facility.

9.3.2 Cost of Using Kate Valley (Economic)

The location of Kate Valley has already impacted on the population of Christchurch. The cost to “dump waste” at a transfer stations has risen over 100% in the past year (refer appendix 5). This is a direct cost of transporting solid waste some seventy kilometres one way to Kate Valley.

With commercial waste companies, Waste Management Ltd and Envirowaste Ltd involved in the Kate Valley Landfill project their main focus is driven by returning a profit to the stakeholders (including the local councils) but at what price to the Christchurch and Canterbury population?

9.3.3 Road Transport

9.3.3.1 Introduction

The road transport section will compare the economic advantages and disadvantages of using road, consider the fuel usage based on either a 20.4 or 22.4 tonne payload. Identify economic benefits and cost reductions.

9.3.3.2 Current Road Transport Operation

The current road transport system used by CWS to deliver waste to Kate Valley is efficient and offers the following advantages:

- A three hour turnaround time from the transfer station to Kate Valley and return
- Delivers a constant amount of waste to the Kate Valley Landfill operation
- Does not require additional handing facilities for the containers (capital costs)
- Few truck breakdowns (excluding punctures) acceptable maintenance costs
- In a 12 hour day the CWS fleet of trucks make up to 48 return trips to Kate Valley (96 Containers)

From an operational point of view, the road transport option suffers from conditions outside of their control which impact on the system. These and other issues are listed below:

- High transport operating costs (fuel price increases) diesel fuel over $1.10 cents per litre (cpl)
- High fuel consumption, an average of 1.76 kilometres per litre of fuel used
- Ongoing Road User Chargers (RUC)
- High construction cost for closed containers due to price of steel
- High maintenance costs of the container fleet
- Requires a team of nineteen truck drivers (high labour costs)

9.3.3.3 Road Transport Fuel Costs

The road transport operation can be broken down in to three segments:

1. Transport from the transfer stations to the beginning of SH1 at Belfast,
2. SH1 from Belfast to the intersection of SH1 and SH7 (south of Waipara)
3. From the intersection of SHI and SH7 to Kate Valley on the Mount Cass road.

Segments one and three because of the short distances with stop / start driving in Christchurch and the hill climb on the Mount Cass Road to Kate Valley, the fuel consumption has been set at 61 litres per one hundred kilometres. Segment two is open road driving has been set at 55 litres per one hundred kilometres

This gives an average fuel consumption of approximately 57 litres per one hundred kilometres (1.75 kilometres per litre).

The fuel consumption of the CWS Mercedes trucks is relatively high compared to other makes of trucks, some of which average between forty five and fifty litres per one hundred kilometres while meeting the Euro 3 specifications (Ward, 2006).

9.3.3.4 Comparison Between 20.4 tonne and 22.4 tonne Payloads

A comparison of using closed containers with a payload of 20.4 tonnes in Table 59 and the open top containers with a payload of 22.4 tonnes in Table 60.

9.3.3.5 Closed Containers

Road Transport	Closed Containers		Payload 20.4 [t]	
			57 litres per 100 kilometres	
Transfer Station	**Total Road [km]**	**Trip Numbers**	**Total Distance [km]**	**Total Litres of Fuel Used**
Parkhouse	83	6,709	556,847	317,403
Metro	81	4,920	398,520	227,156
Styx Mill	68	3,208	218,144	124,342
Totals		14,837	1,173,511	668,901
One Way			1,173,511	668,901
Total Return Trips Kilometres and Fuel Used			**2,347,022**	**1,337,803**

Table 59 Road Option Using Closed Containers and a 20.4 tonnes Payload (Author, 2006).

9.3.3.6 Open Top Containers

Road Transport	Open Top Containers		Payload 22.4 [t]	
			57 litres per 100 kilometres	
Transfer Station	**Total Road [km]**	**Trip Numbers**	**Total Distance [km]**	**Total Litres of Fuel Used**
Parkhouse	83	6,110	507,130	289,064
Metro	81	4,481	362,961	206,888
Styx Mill	68	2,987	203,116	115,776
Totals		13,578	1,073,207	611,728
One Way			1,073,207	611,728
Total Return Trips Information			**2,146,414**	**1,223,456**

Table 60 Road Option Using Closed Containers and a 22.4 tonnes Payload (Author, 2006).

The comparison between 20.4 and 22.4 tonne payloads above shows that with the higher payload of 22.4 tonnes the number of trips to Kate Valley can be reduced. The direct benefits of using the higher payload are saving of:

- A reduction of 1259 return trips per annum to Kate Valley
- A reduction of 200,608 kilometres travelled per annum
- A fuel saving of 114,347 litres per annum

9.3.3.7 Indirect Savings and Benefits

The flow on effect of the cost savings listed above for the road transport operation:

- A reduction in RUC charges
- Reduced number of truck services as the trucks travel less kilometres
- Less tyre wear (replacement and repairs)
- A reduction in driver hours
- Reduced driver costs
- The ability to reduce the number of operating days per week (overtime)

9.3.3.8 Rail Transport

9.3.3.9 Introduction

The rail transport section will compare the economic advantages and disadvantages of using road, consider the fuel usage based on either a 20.4 or 22.4 tonne payload. Identify economic benefits and cost reductions.

9.3.3.10 Rail Transport Fuel Consumption

The proposed rail transport (intermodal) operation from the transfer stations to Kate Valley is broken down in to three segments:

1. Road transport from the transfer stations to the nearest rail facility listed below:
    - Parkhouse Middleton over-bridge
    - Metro Woolston railways yards
    - Styx Mill Northwood on Radcliffe Road
2. Rail transport from the three rail facilities in Christchurch to the Glasnevin rail yard (south of Waipara)
3. From Glasnevin to Kate Valley by road

Segments one and three because of the short distances with stop / start driving in Christchurch and the hill climb on the Mount Cass Road to Kate Valley, the fuel consumption has been set at 61 litres per one hundred kilometres.

Segment two which uses rail transport, a fuel figure of 875 litres for the rail return trip has been set. This has been arrived at by the following method:
;
A train with 50 full wagons (UK, UKA type) (100 containers) pulled by a combination of DX, DQ and DFT locomotives. Each rail wagon has 2 waste containers.

The distance from the three rail facilities in Christchurch to Glasnevin is between 58 and 79 kilometres, with average distance of 71 kilometres one way or 142 kilometres for the return trip. The main rail gradients are from the Sefton bank to Balcairn, seven kilometres and from Amberly to the top of the Amberly bank, six kilometres when the locomotives would use the most fuel.

From past experience and information from within the New Zealand rail industry, two DX locomotives pull a train of a similar weight, an approximate figure of 100 kilometres per 712 litres can be achieved (Informants details are commercially sensitive).

Using the 712 litres figure a train is able to achieve a 7.1 litres per kilometre. The average return trip from Christchurch to Glasnevin would use approximately 1,000 litres. There for weighting the Christchurch to Glasnevin would be:

- 75% from Christchurch to Glasnevin uphill (full), so 750 litres
- 25% from Glasnevin to Christchurch down hill (empty), 250 litres

With conservation measures being adopted by Toll Rail of shutting down the rear locomotives on return (empty) trips, the average figure for the return trip would be 125 litres.

The actual figure for the return trip is between 850 and 900 litres allowing for variables like waiting time, speed and head winds. For this research the average figure of 875 litres for the return trip (437.5 one way) will be used.

Note The measures used to conserve fuel do not take in to account the wear and tear on the locomotives braking systems by shutting down a locomotive.

9.3.4 Comparison Between 20.4 tonne and 22.4 tonne Payloads

A comparison was undertaken using closed container with a payload of 20.4 tonnes in Table 61and the open top containers in Table 62 with a payload of 22.4 tonnes.

9.3.4.1 Closed Containers

Rail Transport		Payload 20.4 [t]							
	Total Road	Fuel at .61 / km	Road Trips	Road Fuel / Trip [l]	Total Rail [km]	6 Day Rail Trips	Rail Litres One Way	Total Rail Fuel [l]	Total Fuel [l]
Parkhouse	12.2	7.442	6,709	49,928	76	140	437.5	61,250	111,178
Metro	15.4	9.394	4,920	46,218	79	103	437.5	45,063	91,281
Styx Mill	12.3	7.503	3,208	24,070	58	69	437.5	30,188	54,257
Totals			14,837	120,216		312	437.5	136,500	256,716
Fuel Litres One Way									**256,716**
Total Fuel Litres Used									**513,432**

Table 61 Rail Option Using Closed Containers and a 20.4 tonnes Payload (Author, 2006).

9.3.4.2 Open Top Container

Rail Transport		Payload 22.4 [t]							
	Total Road	Fuel at .61 / km	Trips	Road Fuel / Trip [l]	Total Rail [km]	6 Day Rail Trips	Rail Litres One Way	Total Rail Fuel [l]	Total Fuel [l]
Parkhouse	12.2	7.442	6,110	45,471	76	140	437.5	61,250	106,721
Metro	15.4	9.394	4,481	42,095	79	103	437.5	45,063	87,157
Styx Mill	12.3	7.503	2,987	22,411	58	69	437.5	30,188	52,599
Totals			13,578	109,977		312	437.5	136,500	246,477
Fuel Litres One Way									**246,477**
Total Fuel Litres used									**492,954**

Table 62 Rail Option Using Closed Containers and a 22.4 tonnes Payload (Author, 2006).

The comparison between 20.4 and 22.4 tonne payloads above shows that with the higher payload of 22.4 tonnes the number of trips to Kate Valley can be reduced. The direct benefits of using the higher payload are saving of

- A reduction of 1259 return trips per annum to Kate Valley
- Using the average distance of 71 kilometres for rail and 2.3 kilometres for road a reduction of 87,248 kilometres travelled per annum
- A fuel saving of 20,478 litres per annum

9.3.5 Proposed Rail Transport Operation

The proposed rail transport operation offers the following advantages:

- Reduce fuel costs

- Reduction of over 95% of RUC charges
- Reduce the number of truck and trailer numbers
- Less kilometres travelled by the remaining trucks
- Truck and trailer servicing costs saving
- Vehicle Registration and certificate of fitness (COF) costs savings
- Reduce the number of drivers need(labour cost savings)
- Able to deliver 100 containers to Glasnevin daily
- Rail facility could handle additional trains per day

From an operational point of view, the rail road transport option could suffer from the following issues:

- High capital cost to set up rail siding at Parkhouse*
- High capital cost to set up rail siding at Styx Mill
- High capital cost to set up rail facility at Glasnevin
- The amount of land able to be purchased at Glasnevin
- The ability of Glasnevin rail facility to handle increase volumes of waste (additional trains on a daily basis)

Note *There is an existing rail branch line from Middleton into the area behind the Parkhouse Transfer Station site which was purchase in 2002 by CCC, which may be able to be used to load and unload containers of solid waste (refer appendix 18).

9.3.6 Comparison of Road and Rail Operations

9.3.6.1 Introduction

This section compares road trips to rail trips to determine the fuel use of both options using both closed and open top containers and 20.4 tonnes payload and 22.4 tonnes payload.

9.3.6.2 Comparison of Fuel Use between Road and Rail Transport

By increase the road transport payload from 20.4 tonne to 22.4 tonne payload there is a potential saving is 114,347 litres per annum could be achieved.

By increasing the proposed rail transport payload from 20.4 tonne to 22.4 tonne payload a potential saving of 20,478 litres per annum could be achieved.

A comparison using the 20.4 tonne payloads using closed containers for both road and rail shows a potential saving using rail of 824,371 litres per annum

A comparison using the 22.4 tonne payloads using open top containers for both road and rail shows a potential saving using rail of 730,502 litres per annum in Table 63.

Containers	Payload	Road Fuel Used Litres	Rail Fuel Used Litres	Fuel Saving Litres	Fuel Saving [%]
Closed	20.4[t]	1,337,803	513,432	824,371	**61.7**
Open Top	22.4 [t]	1,223,456	492,954	730,502	**59.7**
Difference		**114,347**	**20,478**	**93,869**	

Table 63 Comparison of Road and Rail Fuel Usage (Author, 2006).

9.3.6.3 Comparison of Road / Rail Operation

A comparison of staff* and trucks numbers required to operate the road or rail transport option (see Tables 64 and 65 below) using a 20.4 tonne or 22.4 tonne payload

*The operational staff at the transfer stations (META) and at Kate Valley Landfill (CWS) has not been included in this research as they would remain constant with either transport option and have not been included in the comparison.

Closed Container Operation 20.4 tonne Payload

Task Description	Staff Road Transport	Road Operation (Trucks)	Staff Rail Transport	Rail Operation (Trucks)
Drivers at the transfer stations	3	3 Trucks	3	3 Trucks
Truck & trailer units from t/s to Kate Valley	12	12 T & T U#		
Drivers from t/s to rail facility in ChCh			3	3 T & T U#
Staff / Operators on the train to Glasnevin			1	
Staff at Glasnevin			1*	
Glasnevin to Kate Valley			3	3 T & T U#
Total Staff	**19**		**14**	
Total Trucks		**3**		**6**
Total Truck and Trailer Units		**12**		**6**

Table 64 Economic Comparison between Road and Rail Operations using a 20.4 tonne Payload (Author, 2006).

<u>**Note**</u> * The staff member at Glasnevin to operate the gantry crane
3T & TU 3 Truck and Trailer Units

Open Top Container Operation 22.4 tonne Payload

Task Description	Road Transport	Road	Rail Transport	Rail
Drivers at the transfer stations	3	3 T	3	3 T
Truck & trailer units from t/s to Kate Valley	13	11T & T U		
Drivers From t/s to rail facility in ChCh			3	3 T & T U
Staff / Operators on the train to Glasnevin			1	
Staff at Glasnevin			1	
Glasnevin to Kate Valley			3	3 T & T U
Total Staff	**19**		**14**	
Total Trucks		**3**		**6**
Total Truck and Trailer Units		**11**		**6**

Table 65 Economic Comparison between Road and Rail Operations using a 22.4 tonne Payload (Author, 2006).

The comparison reveals that rail transport requires less staff to operate. A potential saving of up to $200,000 per annum could be achieved.

9.3.7 Energy Use

Table 66 shows that twelve truck and trailer units are required to transport 20.4 tonne using a six day, four trips per day operation. If the payload was increased to 22.4 tonne payload (see table 66) using the same operation the numbers of truck and trailer units required is eleven.

Truck and trailer unit numbers would also be able to be reduced with a rail transport option by up to 5 truck and trailer units.

Energy usage will obviously vary depending on vehicle size, load and terrain, but a number of studies have been conducted in the Netherlands, Germany, France and the USA (RRF, 2000), which compare rail and road vehicles. In Table 66 below is a comparison of energy use between modes, although it does not take into account fuel-efficient truck and trailer units.

Mode	Average Energy Used	Minimum Energy Used	Maximum Energy Used
Rail (complete goods train)	1.42	1	1.71
Road (Truck & Trailer Unit)	3.08	2.57	3.57

Table 66 Comparison of Energy Use between Rail and Road (RRF, 2000).

It was found that the energy consumption of rail transport was up to 50% lower than road transport in New Zealand depending on terrain and payloads.

9.3.7.1 Purchase of Land

The present price of land in the area of Glasnevin / Canterbury House Winery is between $28,000 to $35.000 + GST per hectare (2.471 acres). This price includes water rights. The project will require an area of up to twelve hectares at cost of between $336,000 and $420,000.

9.4 Community Issues (Social)

With the location of the landfill at Kate Valley there has been an increase in heavy truck trips on SH1 through Woodend, Leithfield and Amberly including the intersection of SH1 & SH7 (the Kate Valley turnoff). This has impacted on the local communities with increased emissions, noise, vibration and safety issues.

The use of road transport by CWS and accredited private waste companies will continue to impact on these local communities, few solutions can be offered to reduce the impact of heavy truck waste movements except restricting truck trips to daylight hours.

The councils, CWS, waste companies and Land Transport NZ have a responsibility to work together to find innovative solutions, in consultation with the local communities to reduce the impacts or look at alternative options.

The current issues affecting the transportation operation and the landfill operation at Kate Valley are set out below in Table 67. These issues were raised by affected parties to the project including the local councils, the operation company, local businesses, community groups, government departments and the general public.

The life expectancy of Kate Valley is projected to be thirty five years, however at the present rate that solid waste is being sent to Kate Valley it will be full in under than thirty unless action is taken. Then there is the question where to site the next landfill.

The management plan in place for Kate Valley is for thirty five years, but who will be responsible in 60 years time for any environmental issues associated with ground water or soil contamination that may arise? CWS? Transwaste? The CCC? ECAN? or the other local councils? These issues require investigation out side of this research.

The local industries of winemaking, farming, forestry and tourism are dependent on a healthy environment, leachard and ground water contamination are potential hazards. As time progresses the possibility of an earthquake in the region increases, the effect of which is an unknown on the landfill area.

The costs to the landfill operator, local councils and the larger community could have the potential to be significant.

Key Issues	Matters Raised
Transport of solid waste	
	Increase in the number of trucks on the road
	Safety of other road users
	SH1 / SH7 intersection safety
	Noise and vibration on local communities
	Deterioration of road surfaces
	Health concerns on communities from emissions
	An increase in the number of heavy vehicles going to Kate Valley
	Choice of road route
Potential effect on the local industries	
	Tourism
	Wine growing
	Farming
	Forestry
Potential effect on the community	
	Lifestyle and enjoyment of area
	Outsider's perception of the area
	Property values may decrease
	Litter
	Pests
	Long Term responsibility for site environment safety

Table 67 Issues Identified with the Kate Valley Operation (Transwaste, 2001)

9.4.1 Accidents and Congestion

With congestion levels on SH1 from Belfast north increasing the opportunity to reduce the number by over 14,900 return trips would have a major impact on these levels.

In a study on Rail Freight in April 2001 by the Commission for Integrated Transport reported that rail transport in New Zealand had less than 0.5% of the accidents and that the rate of congestion caused by one train was equal to the payload of up to one hundred heavy good vehicles.

9.5 Environmental Impact

9.5.1 Introduction

This section will consider the environmental impacts of transport modes using the following criteria:

- Fuel use
- Air quality / climate change / local air quality
- Noise and vibration
- Accidents and congestion

9.5.2 Fuel Use and Emission Reductions

The reduction in fuel use by introducing rail transport means a reduction in emissions and an improvement in the air quality along the road transport route to Kate Valley. This also reduces the contamination run off on the roads into the surrounding area when it rains.

9.5.3 Emissions Fuel Quality

The trucks used in the road transport operation to Kate valley must all meet Euro 3 (Euro III) emissions specifications. As of the 1^{st} January 2006 fuel regulations were changed to limit sulphur quantities in diesel fuel to 50 parts per million (ppm), this has dramatically reduced the emissions.

The new diesel fuel has 80% less sulphur and emits 25% less fine particulates and soot. Fine particulates are invisible dust-like particles emitted via the exhaust of diesel-powered vehicles. They have been linked to increases in respiratory problems, particularly in cities with smog problems (BP Oil, 2006).

From 1 January 2009, sulphur levels in diesel will be reduced to 10ppm effectively making it 'sulphur-free'. This is due to the advanced Euro 5 technology diesel vehicles entering New Zealand from 2009 onward (Beehive, 2006).

For trucks the standards are defined by engine power, g/kWh, Table 68 below contains a summary of the emission standards for Euro III. Dates in the table refer to new type approvals; the dates for all type approvals are in most cases one year later (European Union type approvals are valid longer than one year).

Note EU Emission Standards for HD Diesel Engines, g/kWh (smoke in m^{-1})

Tier	Date	Test cycle	CO	HC	NOx	PM
Euro III	Oct. 1999 EEVs only	ESC & ELR	1.5	0.25	2	0.02
	Oct. 2000	ECC & ELR	2.1	0.66	5	0.1 0.13*

Table 68 Euro III Emission Standards (Wikipedia, 2006).

Road transport produces high levels of emissions to air and contamination to roads, rail transport also causes emissions to air but at only 10 to 15 % of road levels but causes contamination to the ballast area underneath the rails mainly at workshops, rail stations and shunting areas with diesel, lubricants and oils (Author, 2006).

9.5.4 Noise and Vibration

Although vibration is not an environmental impact, noise and vibration are linked together. Levels of noise generated from transportation are high and generate high levels of complaint. It is estimated traffic noise is a nuisance for 20 to 25% of the population, and railway noise between 2% and 4% (RRF, 2000).

Examples of noise and vibration levels from the different modes include:

- On a single carriageway with three thousand vehicles / day, with 10% heavy goods vehicles, additional trucks would increase noise levels 20 m away by 2-3dB (A)
- On a single carriageway carrying ten thousand vehicles/ day, an additional one hundred and fifty trucks/ day would increase noise levels by 1dB (A)
- Vibration from additional truck and trailer units would be described as negligible.
- Noise from two goods trains can be estimated at nearby sensitive buildings. Night movements would likely cause 85dB (A) at 10 m, which would create a disturbance for nearby property

Day vibration from trains is likely to be negligible, but at night could be considered moderate if there are usually few trains.

CWS is making between eighty and ninety truck and trailer unit movements per day to and from the three transfer stations to Kate Valley. This number of trips equates to an additional 3% of heavy vehicles per day passing through local communities between Christchurch and Kate Valley.

9.5.5 Capital Costs

9.5.5.1 Planning and Resource Consent

Prior to a resource consent application to build the rail facility at Northwood, Parkhouse and Glasnevin an in-depth study would need to be undertaken including a feasibility study, possible designs, impact assessment and a detailed cost analysis of the proposed projects, all in consultation with the with stakeholders, local communities and interested parties.

9.5.5.2 Glasnevin Rail Handling Facility

Once resource consent was approved the project to build a rail sidings and the container handling facility at Glasnevin (a representation of the facility) as shown below in Figure 29 would include the following:

- Placement of new rails for a double track rail siding
- Construction of a container handling facility
- Road access from SH1
- Possible construction of an underpass under SH1
- Re-signalling of the rail line with lights, bells and barrier arms
- Landscaping, bunding and screening of the facility
- The introduction of slow traffic / merging lanes on both sides of SH1

The construction of screening and a litter are seen as important to reduce the noise and visual impact of the facility as shown below in Figure 29.

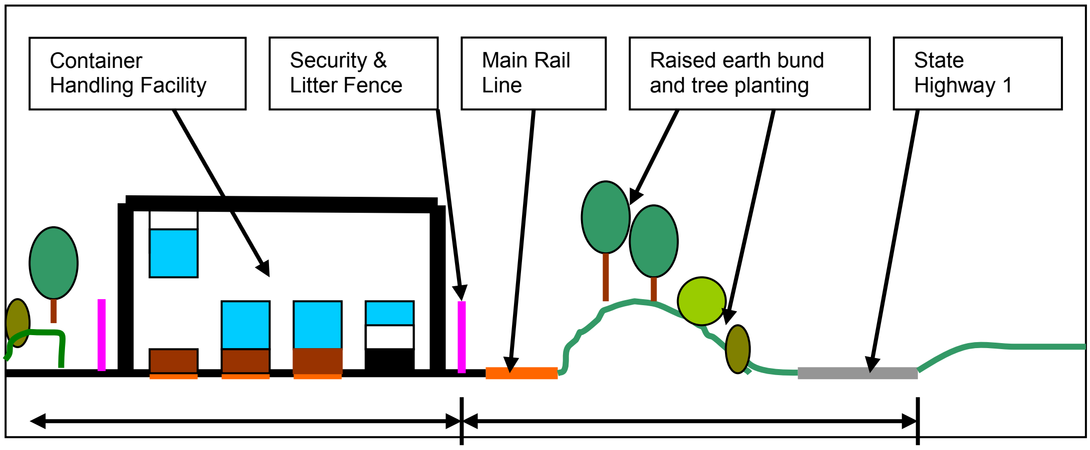


Figure 29 Landscaping at Glasnevin Container Facility (Author, 2006).

9.5.5.3 Road Access and Proposed Under Highway Tunnel

This project would be overseen by Transit New Zealand. It is suggested an off ramp and an under highway tunnel be constructed to eliminate the need for truck and trailer units to cross the centre line if they were coming south from Kate Valley and turning from SH1 into the rail facility. This would eliminate potential accidents.

A separate merging lane from the rail facility going north towards Waipara for 500 metres would assist the truck and trailer units to merge back into the traffic heading north on SH1. This would also eliminate potential road accidents form the operation. Further investigation of this project would need to be undertaken as it is not part of this research.

9.5.6 Container Facility

The construction of a container handling facility at Glasnevin to handle up to one hundred and twenty containers per day will require 840 metres of track in two rail siding shown in Table 69.

	Number of Containers per Day	
	Minimum	**Maximum**
Number of containers	80	120
Number of Rail Wagons	40	60
Length of wagon [m]	14	14
Amount Track Required [m]	**560**	**840**

Table 69 Rail Track Requirements for Glasnevin (Author, 2006).

The area at Glasnevin beside the main rail line highlighted in Figure 30 below is the area proposed for the rail facility. It has significant advantages over locations closer to the Intersection of SH1 and SH7, the area is unpopulated, the rail line runs straight for a distance of over 1km and there is only one minor road intersecting within the proposed area.

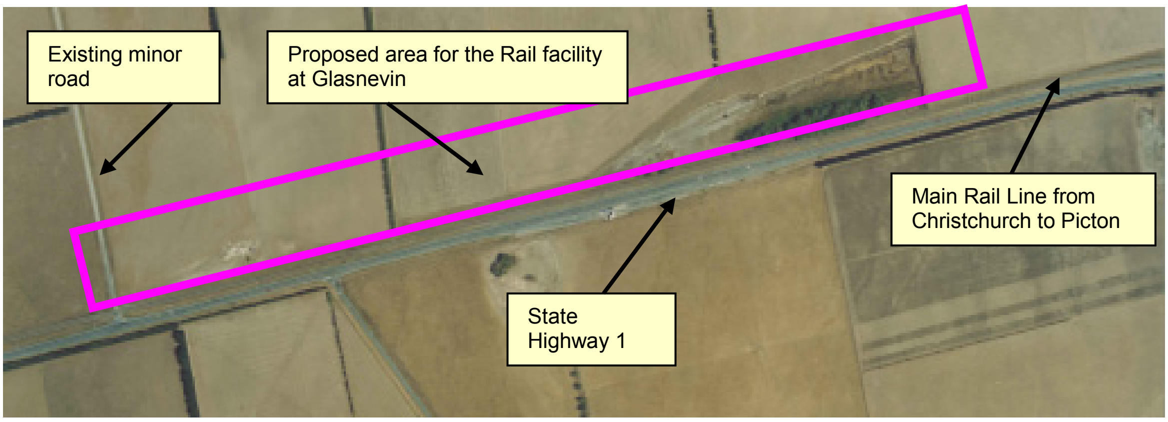


Figure 30 Proposed Area at Glasnevin for the Rail Facility (Transit, 2006c)

9.5.7 Container Transfer Options

The three possible container transfer options are:

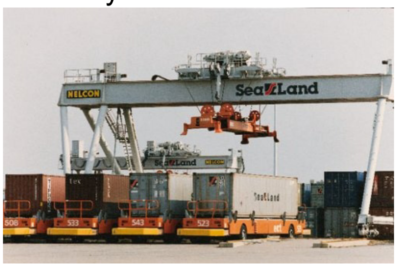
- Cargo Domino Both horizontal and vertical transhipment
- Overhead Gantry Crane
- ACTS System

Below in Figure 31 are photos of the three container transfer option.

Cargo Domino System

(Swissworld, 2006c)

Gantry Container Crane



(OPC Tudelft, 2006)

Hook and Arms System

(Telepresents, 2006)

Figure 31 The Three Proposed Container Transfer Systems for Glasnevin

Of the three transfer systems proposed only two are compatible due to the limited area of operation and the need for specialised rail wagons with the operation proposed, these are:

- The Cargo Domino transfer system
- Overhead Gantry / Container Crane

9.5.8 Comparison

Intermodal transport has been very successful in Europe and America, the benefits of using this type of system far out way the present road transport system used by CWS.

A comparison of a road transport operation or a combination of road / rail transport operation shows the following differences in Table 70 below.

Road Transport	Combination of Road and Rail Transport
Increase in the number of trucks on the road	Decrease in the number of trucks on the road
Safety of road users	Improved safety of road users
SH1 / SH7 intersection safety	Removal of SH1 / SH7 intersection safety concerns
Deterioration of road surfaces	One rail movement per day
Cost of ongoing road maintenance	Build rail siding and SH1underpass at Glasnevin
Increased vehicle emissions	Reduced train / vehicle emissions
Potential effect on the community	Reduction in potential effect on the community
Interruption to lifestyle and enjoyment	Little or no interruption to lifestyle and enjoyment
Outsider's perception of the area	Use of existing Christchurch rail yards & sidings

Table 70 A Comparison between a Road Transport and Road / Rail Transport Operation (Author, 2006).

9.5.9 Comparison between Modes

The comparison model (Table 71) places an estimate of the impact both transport modes have using a triple bottom line (in comparative terms).

Road transport appears to be the least desirable mode of transport in comparison to rail transport. Road transport does have an advantage in terms of flexibility of delivery which rail does not have.

Issue	Road	Rail
Environmental Values		
Noise and vibration		
Emissions to air, water & soil		
Visual intrusion		
Land take (Glasnevin Rail Facility)		
Increased noise & vibrations		
Dust		
Hazardous waste		
Social Values		
Accessibility		
Health & safety		
Employment		
Reduced property values		
Increase number of traffic accidents		
Safety		
Increased traffic volumes		
A reduction in lifestyle enjoyment		
Economic Values		
Location of facilities		
Infrastructure		
Journey length		
Value of waste		
Congestion		
Energy use		
Cost to dispose of waste		
Key		
Likely to have major impact		
Likely to have moderate impact		
Likely to have a low impact		

Table 71 Comparison of Major, Moderate or Low Impact on the Environment between Road and Rail Transport (Author, 2006)*

* The model used above is similar in type to a model used in The Best Integrated Transport Options for Waste in Scotland (Viridis Report VR7 2004).

9.6 Conclusion

Several areas of concern have been identified, which pose risks now and in the future:,

- Impact on the local communities
- Transport safety
- Increased waste disposal costs
- Increasing waste volumes transported to Kate Valley
- Impacts on local industries and businesses
- The potential for an environmental incident
- Lack of a long term risk management plan
- Potential costs to stakeholders of an incident
- Poor sorting of waste (recycling)

The economic, environmental and social impacts of road transport are not as good as than rail. The key environmental impacts of road transport include climate change, poor local air quality, traffic congestion, vehicle safety, noise and social exclusion.

The Commission for Integrated Transport reported that in a study on the Incentives for Rail Freight Growth in April 2001 that moving freight by rail produces the following comparative benefits:

- Fuel Consumption: Rail transport uses less than50% of the energy of road transport
- Emissions: Rail produces only 10% to 20% of the levels of road transport
- Accidents: Less than 0.5% the equivalent rate of road transport accidents
- Congestion: One train can carry the payload of up to 100 heavy good vehicles

Rail transport does cause contamination to the ballast area underneath the rails mainly at workshops, rail stations and shunting areas with diesel, lubricants and oils has been deposited.

10 CONCLUSION and RECOMMENDATIONS

10.1 Introduction

This chapter will provide conclusions and recommendations regarding:

- Transfer stations operations
- Compare road transport to rail transport
- Compare closed and open top container
- Review container transfer systems
- Evaluate the operation using a triple bottom line approach
    - Economic
    - Environmental impacts
    - Community and social impacts

10.2 Transfer Station Operations

This research has identified possible enhancements the present operation of Christchurch's Transfer Stations:

- Possible introduction of new processes and new technology (refer appendix 2
    - Improved resource recovery
    - Reduction in hazardous waste to landfill
    - Introduction of a waste shredder
    - An electromagnet to recover ferrous metals.
- Improved resource recovery
- Review the way containers are loaded with solid waste

10.3 Comparison of Road Transport to Rail Transport

A comparison between road and rail transport has identified that rail transport is a more cost effective transport option to move solid waste from Christchurch to Glasnevin due to the following:

- Reduced operational costs
    - Fuel cost savings
    - Savings in Road User Charges (RUC)
    - Employee costs (reduced staff numbers required)
    - Reduction in the number of truck and trailer units requires
- Reduced emissions
- Improved road safety with reduced less return trips to Kate Valley

10.4 Containers and Transfer Systems

There are several options available using both closed and open top containers:

- Continue to use the closed containers with the present system
- Have the closed containers modified to operate on a rail system
- Continue to use closed containers and replace them with open top containers at the end of their working life
- Scrap the closed containers and introduce open top containers using road transport
- Use open top containers on rail transport

The open top containers offer the following advantages over the close containers

- Able to accept non compacted solid waste
- No need for compaction equipment
- Reduced damage and maintenance
- Cost saving from less damage
- Lighter weight
- Increased solid waste capacity
- Cost savings on construction
- Less trips to Kate Valley

10.5 Environmental Impacts

The key environmental impacts affecting road transport over rail transport include:

- Poor local air quality due to high emissions
- Traffic congestion, 1 train carries the payload of up to 100 heavy goods vehicles
- A 95% higher rate of accidents that with rail transport
- Increase noise levels in local communities
- Social exclusion of communities
- Energy consumption of approximately 50% higher than with rail transport
- Emissions of between 80% to 90% higher than rail transport
- Continued noise and vibration in local communities

10.6 Triple Bottom Line

Rail transport offers the following advantages:

- Reduced congestion in local communities Congestion:
- Improved road safety
- Reduced quantity and level of noise and vibration
- Rail produces only 10% to 20% of the emission levels of road transport
- Cost saving with rail using 60% less fuel tan road.
- Less emissions
- Reduction in the fuel used

The environmental and social impacts of road transport are seen to be inferior to rail transport (see Table 72). The key environmental impacts of road transport include climate change, poor local air quality, traffic congestion, accidents, noise and social exclusion.

	Road	Rail	Outcome
Energy Consumption:	1,223,456 litres	492,954 litres	Rail uses 61% less fuel than road
Emissions:	100%	15%	Rail emits 85% less emissions than road
Accidents:	100%	0.50%	Rail has 95% less accidents than road
Congestion:	100	1	One train is equal to 100 truck and trailers

Table 72 Comparison between Road and Rail transport (Author, 2006)

On the negative side, rail transport causes contamination to the ballast area underneath the rails mainly at workshops, rail stations and shunting areas with diesel, lubricants and oils has been deposited.

10.7 Conclusion and Recommendations

Based on the conclusions, I would consider rail transport the more economic option to be considered, the fuel saving of rail over road are substantial. Although the setup costs to implement a rail transport option are high the economic return in fuel savings over a ten year period in the area of 7 to 8 million dollars.

Table 73 shows a comparison between using road transport and rail (intermodal) transport. The outcome is the benefits of rail transport far out way road transport from a triple bottom line point of view.

Road Transport	Combination of Road and Rail Transport
Increase in the number of trucks on the road	Decrease in the number of trucks on the road
Over 14900 return trips per annum	Reduced road kilometres
Safety of road users	Improved safety of road users
SH1 / SH7 intersection safety	Removal of SH1 / SH7 intersection safety concerns
Deterioration of road surfaces	One rail movement per day
High levels of noise and vibration	Less noise and vibration with one train a day
Cost of ongoing road maintenance	Build rail siding and SH1underpass at Glasnevin
High vehicle emissions	Reduced train / vehicle emissions
Potential effect on the community	Reduction in potential effect on the community
Interruption to lifestyle and enjoyment	Little or no interruption to lifestyle and enjoyment
Outsider's perception of the area	Use of existing Christchurch rail yards & sidings

Table 73 Comparison between Road and rail transport (Author, 2006).

The improved safety for residence in Christchurch and in the towns on the route to Kate Valley, reduced health problems associated with vehicle emissions, improved lifestyle and enjoyment of the population. These things are not something a value can easily be placed on but they impact on most of the Christchurch population in some way.

Based on the findings of this research I recommend that the whole community would be better served by them making the decisions on the following:

- Which mode of transport should be used
- The introduction of an improved waste management processes
- The Introduction of new technology
- Which container should be used

These decisions are too important to be left to the councils and businesses associated with running and profiting from the solid waste disposal operation as they have a vested interest in the present system.

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12 APPENDICES

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Appendix 1 Research Schedule

The research will begin with a review of what has been written on the subject of the transfer of solid waste to landfills both in New Zealand and overseas, to identify potential opportunities and impediments in the existing system used for metropolitan Christchurch to Kate Valley.

An analysis of the data gathered during this review will be undertaken to understand what tends it shows and how these impact on the environment and communities.

Stage One
Carry out a literature review on:

- What has happened over the last ten years to the disposal of solid waste in Christchurch and the Canterbury region
- How a change in the way solid waste is transported has affected local communities in the Canterbury Region?
- Examine if these changes had a positive or negative impact on the environment and community.
- Has any changes had an impact on the volume of waste.
- Identify existing legislation and proposed changes that may impact on transport options

Stage Two
Consider the different transport options available

- Trucking
- Rail
- Ship
- Other options
- Research traffic flows and volumes
- Obtain solid waste volumes

Stage Three
Collect data on transport equipment costs, operating costs, personnel costs, taxes and charges, fuel and profit margins.
Number crunch the data to provide information that is comparable to existing operations.

- Evaluation of the economic options (spreadsheets)
- Visit Kate Valley Landfill Site and local district
- In depth analysis of outputs
- Evaluating of impacts of transport options on:
    - The environment
    - The social impacts on the community
    - Sustainability of the existing or any other option
    - Public and operational safety

Stage Four
Identify stakeholders

- Consult with the stakeholders on the information gathers to receive their feedback
- Evaluating the stakeholders feedback
- Identifying outputs
- Finalising results / figures

Stage Five
Prepare a draft of dissertation

- Evaluation of options
- Discussion of options
- Conclusion

This study is limited to researching only transportation options of solid waste from the Canterbury Region to the Kate Valley Landfill entrance. It is not looking at the operation or management of the landfill, or the collection of solid waste within the Christchurch metropolitan areas

Appendix 2 Suggested Modification to Existing Transfer Stations

Proposed Sorting / Open Top Container Loading System

With the proposed use of open top containers a review of the waste management operation at the transfer stations and the introduction of an improved recycling recovery system could further reduce the amount of waste sent to landfill.

When the waste first arrives at the transfer station recycle area, all direct delivered solid waste is check for recyclable products and any hazardous waste. Once these items have been removed the waste is allowed to be put on the transfer station floor.

This work could be carried out by pre released prisoners from either Rolleston or Christchurch prison, after the prisoners have been trained in resource recovery and hazardous waste identification including them passing an approved hazardous substances handlers certificate. This work could:

- Assist the pre release prisoners to integrate back into the community
- Help them rebuild their work ethic
- Provide them with transferable skills

This area requires further investigation as it is not part of this research.

From the transfer station floor all solid waste is processed through a shredder. The vertical shredding equipment shown in Figure 32 below reduces the waste to the consistency of plant material. This process increases the maximum quantity of waste that can be loaded in to the open top containers, removing air pockets.

The waste passed under an electromagnet shown below into separate any remaining ferrous metal from the waste conveyor system, before being loaded into open top containers. The electromagnet is able to handle wet, dry, fine or coarse materials.

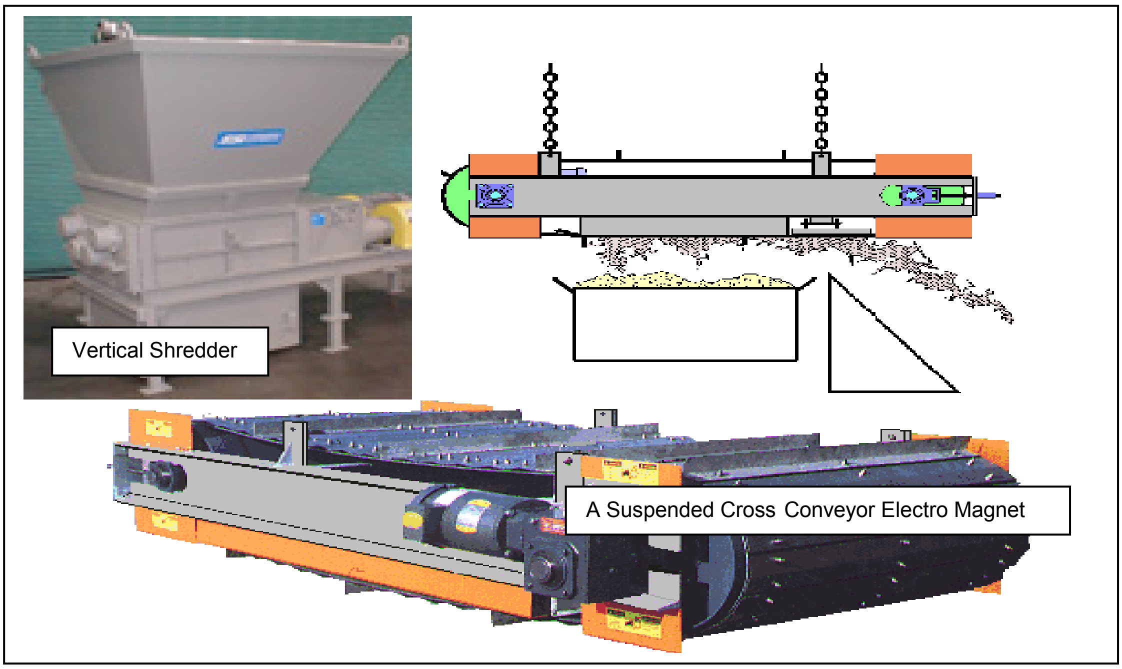


Figure 32 The introduction of new Technology to the Transfer Station Operation. (A & A Magnetics Inc, 2006).

With the proposed introduction of a conveyor system, commercial shredder and electromagnet into the container filling operation for open top containers, it may provide the following benefits:

- Reduction in the amount of ferrous metals going to the landfill by up to 90%
- More even filling of containers
- Reduced damage to the containers during the filling process
- Easier unloading at the landfill (fewer obstructions)
- Quicker breakdown of solid waste in the landfill

Below in Table 74 is a list of the benefits on the introduction of new technology to the transfer station operation.

Introduction of Technology	Benefits to Recycling
Shredder	
	Maximized loading capacity
	Reduce empty space in containers
	Faster loading of containers
	Waste easier to compact at a landfill
	Faster breakdown of waste
Electromagnet	
	Less recyclable products sent to landfill
	Increased ferrous metal recovery

Table 74 Benefits of the Introduction of New Technology (Author, 2006).

Appendix 3 Layout Change for Styx Mill Transfer Station

Below is two diagrams, (see Figure 33) one is of the existing transfer station operation at Styx Mill and the second (see figure 34) shows a diagram of the proposed changes to the transfer station operation including changes to the loading operation with the introduction of a shredder, conveyer system and electromagnet.

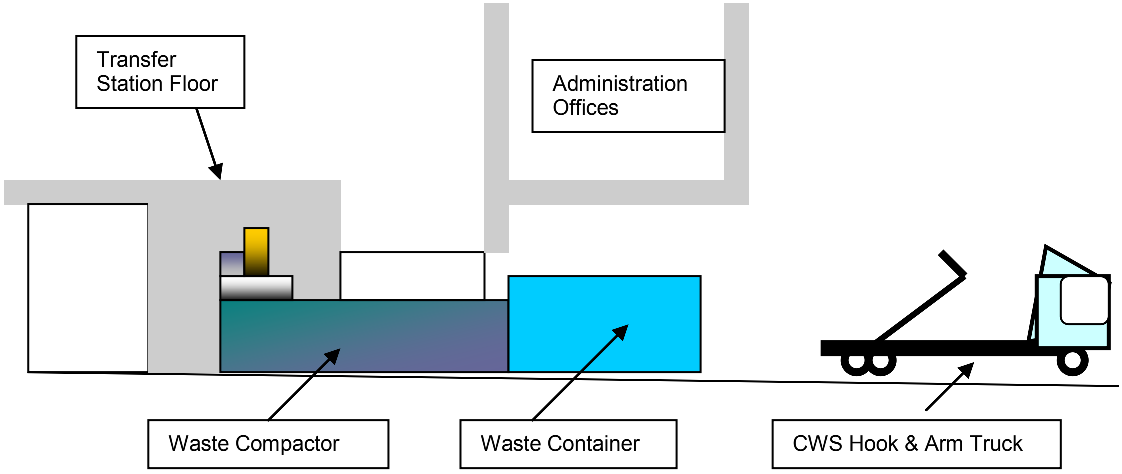


Figure 33 The Existing Styx Mill Transfer Station Cross Section. (Author, 2006)

Below is the proposed transfer station System including the introduction of shredder, conveyor system, electromagnet and moving chain grate for the containers.

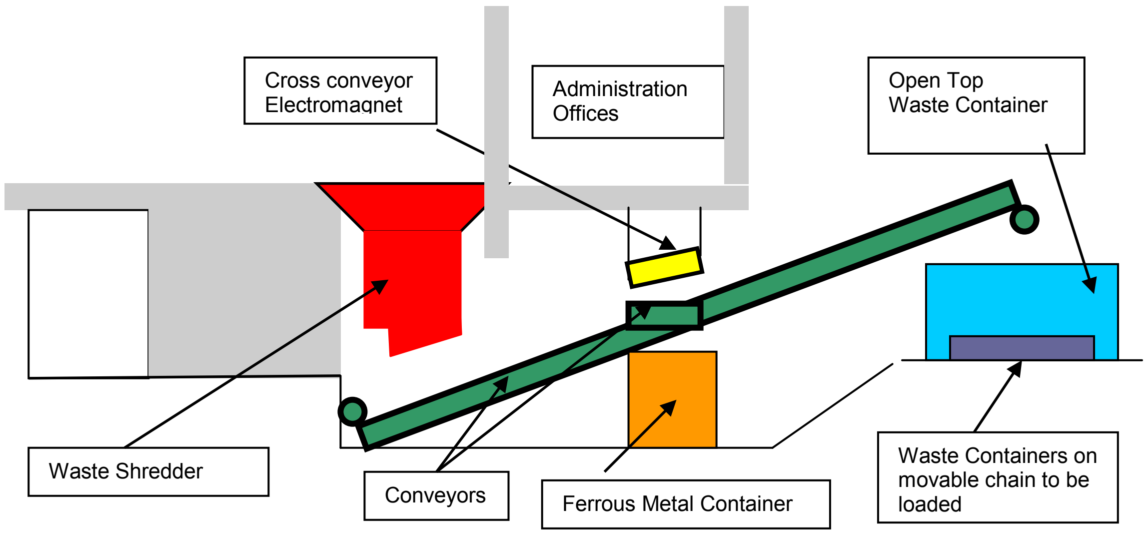


Figure 34 Proposed Changes to the Styx Mill Transfer Station. The Introduction of a Shredder, Electromagnet and New Conveyor Loading System (Cross Section View) (Author, 2006).

Appendix 4 **Existing Transfer Station at Styx Mill**

Below in Figure 35 is the existing transfer station at Styx Mill (not to scale)

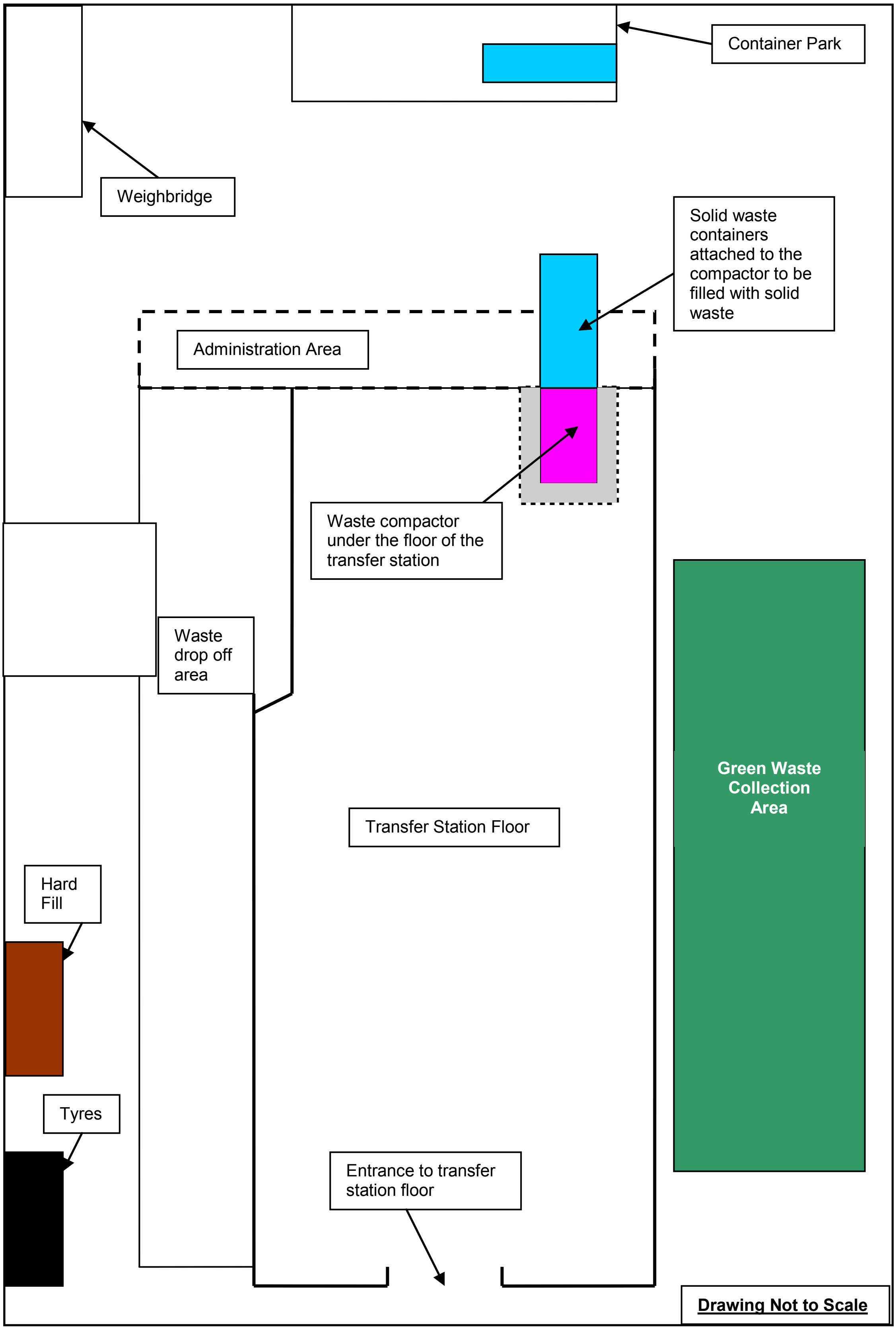


Figure 35 Existing Transfer Station Layout at Styx Mill (Author, 2005)

Appendix 5 **Proposed Changes to the Styx mill Transfer Station**

Below in Figure 36 is the existing transfer station at Styx Mill (not to scale)

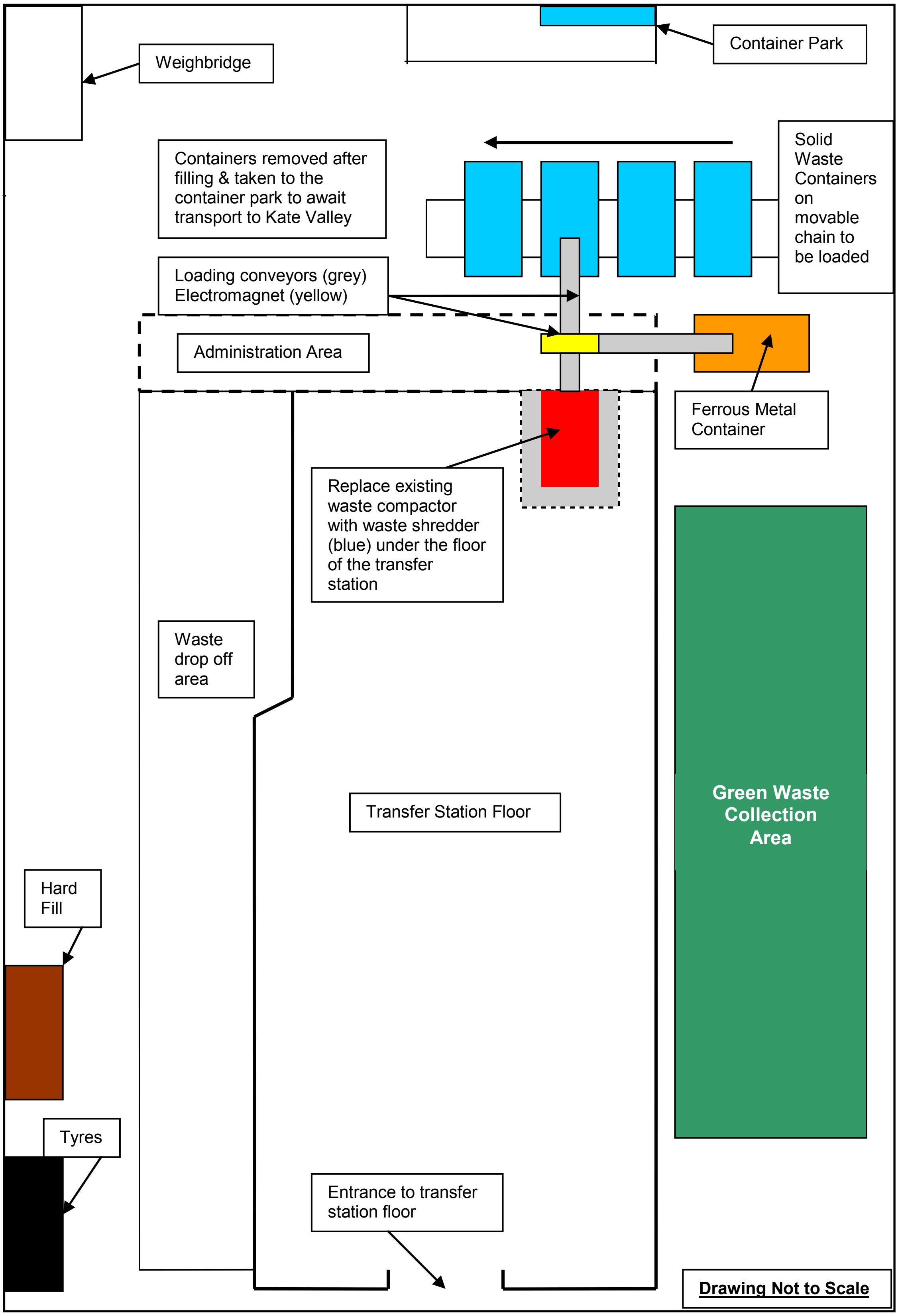


Figure 36 Proposed Changes to the Transfer Station Layout and Operation at Styx Mill (Author, 2005).

Appendix 6 Proposed Cargo Domino Container Handling Facility at Glasnevin

Figure 37 shows Option one for Glasnevin using a Cargo Domino System

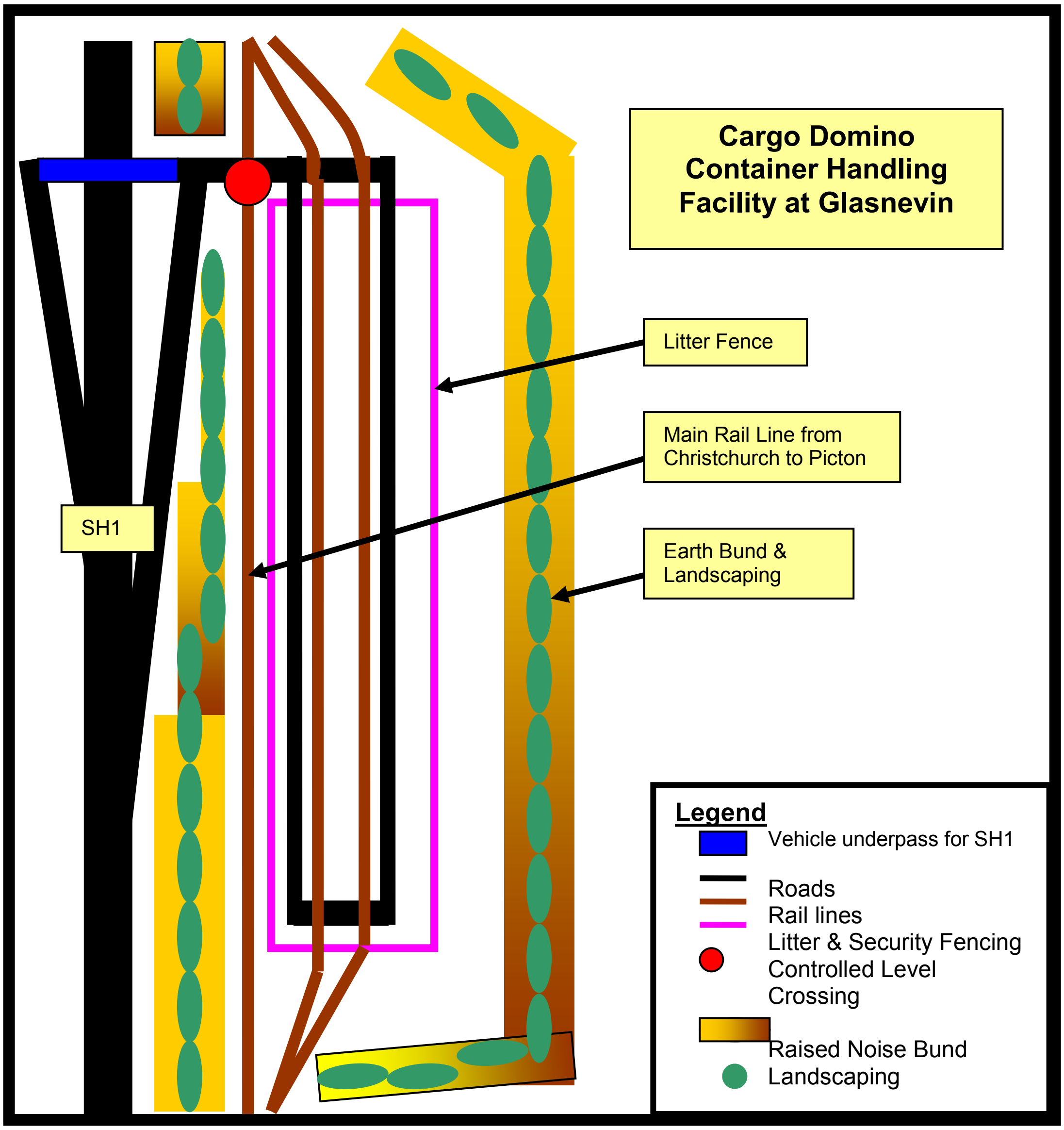


Figure 37 Proposed Layout of the Cargo Domino Rail and Container Handling Facility layout at Glasnevin (Author, 2005).

Appendix 7 Proposed Container Gantry Crane Handling Facility at Glasnevin

Figure 38 Shows Option two for Glasnevin using an Overhead Gantry Crane.

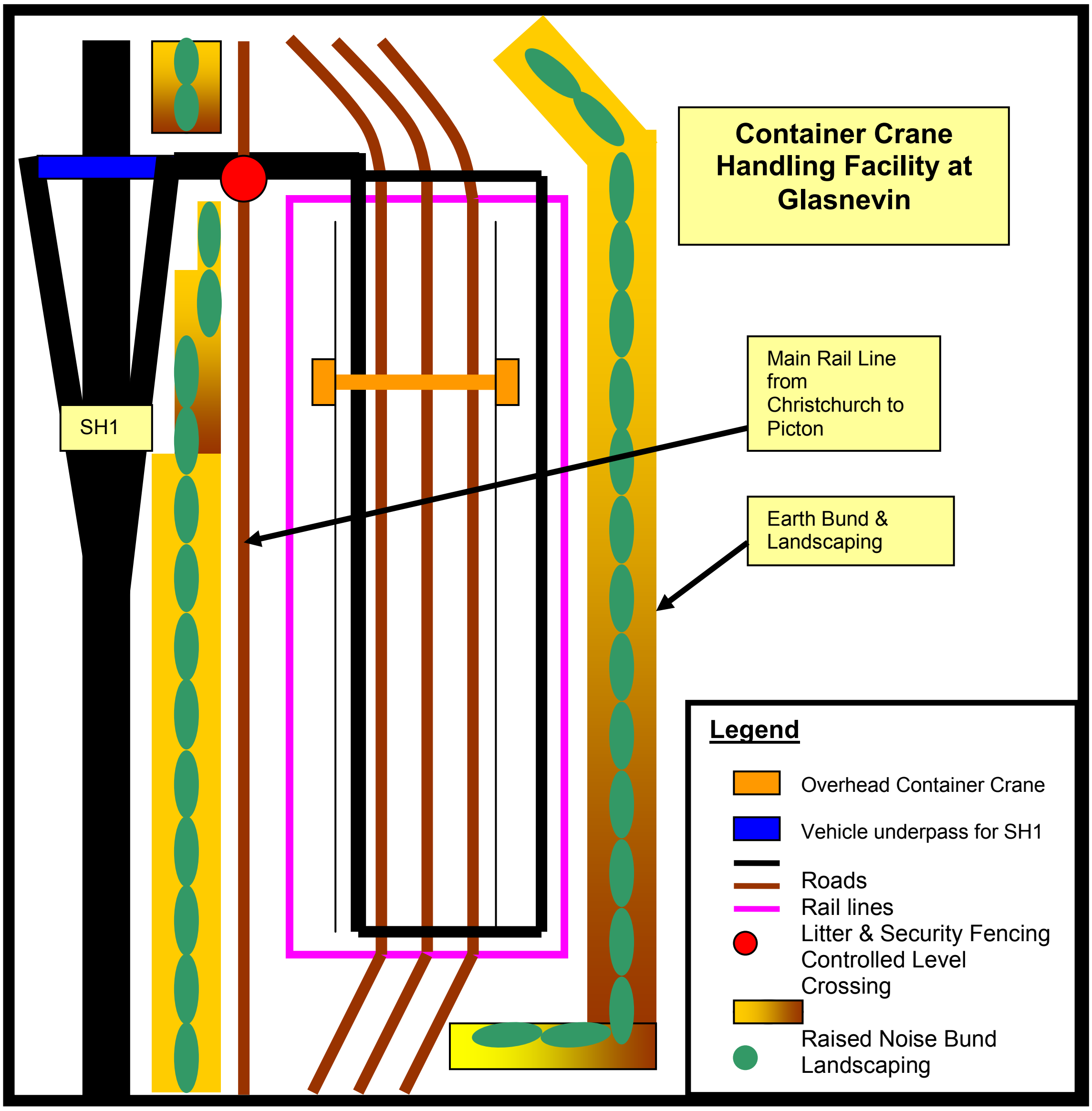


Figure 38 Proposed Layout of the Overhead Gantry Crane Rail and Container Handling Facility layout at Glasnevin (Author, 2005).

Appendix 8 Christchurch Transfer Station Charges

Below in Table 75 is a list of the charges for waste in Christchurch Transfer Stations

It doesn't matter how big or small a load is when visiting an EcoDepot; loads are weighed at the kiosk on entry and the type of load is identified, with the exception of household loads of green only. Vehicles are then weighed again when leaving. The difference is the net weight and that is what the customer is then charged for. See the following chart with load types and the fee charged.
See the following chart with load types and the fee charged. Current at 20 June 2006.
Please note: prices include GST. and Prices are subject to change without notice.

REFUSE - all non hazardous waste except animal manure and liquid waste		
Private and Commercial:	**Current fee:**	
All vehicle types	$135.00 per tonne	
- Minimum Charge - per weigh	$6.50 per weigh	
GREEN - garden waste, leaves, branches, unsprayed lawn clippings, weeds		
Household Green ONLY To reduce potential delays, especially at weekends, household loads of green only are charged at the following fees (including GST)	**Normal**	**Senior Citizens*** mon-thus only
Cars / Hatchbacks	$4.50	$3.50
Station Wagons / Small 4x4s	$5.00	$4.00
Low-sided trailers / Utes / Vans / Large 4x4s	$10.00	$8.00
High-sided trailers / others	$15.00	$12.00
Customers with household loads of green can ask to be charged by weight if they wish. Please do not ask to change your decision as to a fixed fee/fee based on weight after you have passed over the entry weighbridge; this is not possible. Sorted mixed loads (e.g. green/refuse), refuse and all commercial loads are weighed and charged for by weight at a per tonnage rate. **Senior Citizen Discount*** This discount applies Monday-Thursday only. A Senior Citizen card or other relevant identification may be required.		
Green by Weight		
All vehicle types	$65.00 per tonne	
Minimum charge	$5.00 per weigh	
ASBESTOS - Metro Place at Bromley only.		
All vehicle types	$230.00 per tonne	
Minimum charge	$11.00 per weigh	
POLYSTYRENE		
All vehicle types	$1550.00 per tonne	

Minimum charge	$7.00 per weigh
HARDFILL - rubble, concrete, soil, bricks, stones, pavers, sand	
Household loads only	$43.00 per tonne
Minimum charge	$6.00 per weigh
SORTED MIXED LOADS - must be more than 50% green and easily separable Commercial loads must be double weighed; otherwise they will be charged at general refuse fee rates	
Household and Commercial:	
Mixed Load Refuse & Green	$100.00 per tonne
Mixed Load Hardfill & Green	$65.00 per tonne
Mixed Load Hardfill & Refuse	$89.00 per tonne
Minimum charge	$6.00 per weigh
TYRES	
Domestic:	
Car tyres	$3.50
4WD	$5.50
Truck	$12.00
Tractor	$20.00
Rim removal	$2.00
Per metric tonne	$400.00

Please note:
With the exception of green, all vehicles are weighed and charged based on the net weight of material being disposed of.
To reduce delays and queues, household loads containing only green are charged at a fixed fee per vehicle. Customers may ask to be charged by weight if they wish.

Table 75 Christchurch Transfer Station Charges (CCC, 2006h).

Appendix 9 **Ariel Photos of Glasnevin & The intersection of SH1 & SH7**

Figure 39 Glesieven Straight, Photo Number 1 from Amberley (Transit, 2006c).

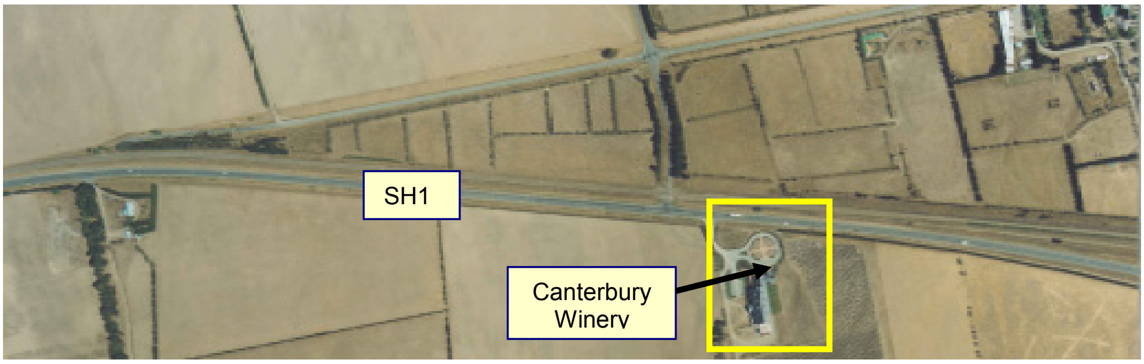


Figure 40 Glasnevin Strait, Photo Number 2 (Canterbury Winery Highlighted in Lower Right) (Transit, 2006c).

Figure 41 Intersection of State Highway 1, State Highway 7 and Mt Cass Road North Canterbury (Transit, 2006c).

Appendix 10 Road Transport Operation Container Numbers

The same set of tables (4) for Parkhouse, Metro and Styx Mill are used for each with closed containers for 20.4 tonne and 21.4 tonne payloads. Open top containers for a 22.4 tonne and 23.4 tonne payloads. Using the master calculation table below with the number of trucks from each table and the number of trips you are able to identify the number of containers requires for each scenario (see Table 76).

Example
From the first table for Parkhouse of 20.4 tonne payload with closed containers using a seven day operation with three return trips per day.

So three return trips by six truck and trailer units using the master calculation table, the answer is 36 containers

Master Calculation Table Used to Identify the Number of Containers Needed

	Number of Return Trips to Kate Valley				
Number of Truck & Trailer Units Required per Transfer Station	**1 Return Trip / Day**	**2 Return Trip / Day**	**3 Return Trip / Day**	**4 Return Trip / Day**	**5 Return Trip / Day**
1	4	6	6	6	6
2	8	12	12	12	12
3	12	18	18	18	18
4	16	24	24	24	24
5	20	30	30	30	30
6	24	36	36	36	36
7	28	42	42	42	42

Table 76 Master Calculation Table Used to Identify the Number of Containers Needed (Thull, 2006).

Parkhouse

2005

20.4 tonne Payload Using Closed Container

Parkhouse Transfer Station				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
136,867		20.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
129	18.4->19		21.5->22	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	6.3	4.8	7.3	5.5
Number of Trucks	6	5	7	6
	6 Trucks	5 Trucks	7 Trucks	6 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	36	30	42	36
20% allowance	7	6	8	7
Total Containers	43	36	50	42

Table 77 20.4 tonne Payload Using Closed Container (Author, 2006).

21.4 tonne Payload Using Closed Container

Parkhouse Transfer Station				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
136,867		20.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
123	17.6->18		20.5->21	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	6	4.5	7	5.3
Number of Trucks	6	5	7	5
	6 Trucks	5 Trucks	7 Trucks	5 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	36	30	42	30
20% allowance	7	6	8	6
Total Containers	43	36	50	36

Table 78 21.4 tonne Payload Using Closed Container (Author, 2006).

22.4 tonne Payload Using Open Top Container

Parkhouse				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
136,867		22.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
118	16.9->17		19.7->20	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	5.7	4.4	6.7	5
Number of Trucks	6	4	7	5
	6 Trucks	4 Trucks	7 Trucks	5 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	36	24	42	30
20% allowance	7	5	8	6
Total Containers	43	29	50	36

Table 79 22.4 tonne Payload Using Open Top Container (Author, 2006).

23.4 tonne Payload Using Open Top Container

Parkhouse				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
136,867		23.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
112	16		18.7->19	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	5.3	4	6.3	4.8
Number of Trucks	5	4	6	5
	5 Trucks	4 Trucks	6 Trucks	5 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	30	24	36	30
20% allowance	6	5	7	6
Total Containers	36	29	43	36

Table 80 23.4 tonne Payload Using Open Top Container (Author, 2006).

METRO

2005

20.4 tonne Payload Using Closed Container

Metro				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
136,867		23.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
95	13.6->14		15.8->16	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	4.6	3.5	5.3	4
Number of Trucks	**5**	**4**	**5**	**4**
	5 Trucks	4 Trucks	5 Trucks	4 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	**30**	**24**	**30**	**24**
20% allowance	6	5	6	5
Total Containers	**36**	**29**	**36**	**29**

Table 81 20.4 tonne Payload Using Closed Container (Author, 2006).

21.4 tonne Payload Using Closed Container

Metro				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
100,369		21.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
90	12.9->13		15	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	4.3	3.3	5	3.8
Number of Trucks	**4**	**3**	**5**	**4**
	4 Trucks	4 Trucks	5 Trucks	4 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	**24**	**24**	**30**	**24**
20% allowance	5	5	6	5
Total Containers	**29**	**29**	**36**	**29**

Table 82 21.4 tonne Payload Using Closed Container (Author, 2006).

22.4 tonne Payload Using Open Top Container

Metro				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
100,369		22.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
86	12.3->13		14.3->15	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	4.3	3.3	5	3.8
Number of Trucks	4	3	5	4
	4 Trucks	3 Trucks	5 Trucks	4 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	24	18	30	24
20% allowance	5	4	6	5
Total Containers	29	22	36	29

Table 83 22.4 tonne Payload Using Open Top Container (Author, 2006).

23.4 tonne Payload Using Open Top Container

Metro				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
100,369		23.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
82	11.7->12		13.6->14	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	4	3	4.7	3.5
Number of Trucks	4	3	5	4
	4 Trucks	3 Trucks	5 Trucks	4 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	24	18	30	24
20% allowance	5	4	6	5
Total Containers	29	22	36	29

Table 84 23.4 tonne Payload Using Open Top Container (Author, 2006).

Styx Mill

2005

20.4 tonne Payload Using Closed Container

Styx Mill				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
66,912		20.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
63	9		10.5->11	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	3	2.3	3.7	2.8
Number of Trucks	3	2	4	3
	3 Trucks	2 Trucks	4 Trucks	3 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	18	12	24	18
20% allowance	4	2	5	4
Total Containers	22	14	29	22

Table 85 20.4 tonne Payload Using Closed Container (Authior,2006).

21.4 tonne Payload Using Closed Container

Styx Mill				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
66,912		21.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
60	8.6->9		10	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	3	2.3	3.3	2.5
Number of Trucks	3	2	3	3
	3 Trucks	2 Trucks	3 Trucks	3 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	18	12	18	18
20% allowance	4	2	4	4
Total Containers	22	14	22	22

Table 86 21.4 tonne Payload Using Closed Container (Author, 2006).

22.4 tonne Payload Using Open Top Container

Styx Mill				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
66,912		22.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
57	8.1->8		9.5->10	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	2.7	2	3.3	2.5
Number of Trucks	3	2	3	3
	3 Trucks	2 Trucks	3 Trucks	3 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	18	12	18	18
20% allowance	4	2	4	4
Total Containers	22	14	22	22

Table 87 22.4 tonne Payload Using Open Top Container (Author, 2006).

23.4 tonne Payload Using Open Top Container

Styx Mill				Road
Waste per Annum [t]		Truck and Trailer / Trip [t]		
66,912		23.4		
Return Trips / Week	7 Day Operation		6 Day Operation	
55	7.9->8		9.2->9	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	2.7	2	3	2.5
Number of Trucks	3	2	3	3
	3 Trucks	2 Trucks	3 Trucks	3 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Container Numbers	18	12	18	18
20% allowance	4	2	4	4
Total Containers	22	14	22	22

Table 88 23.4 tonne Payload Using Open Top Container (Author, 2006).

Appendix 11 Summary Tables for 6 and 7 Days a Week for 2005

6 Day a Week Operation for 2005

Trips per Day	Parkhouse		Metro		Styx Mill	
	6 Days		6 Days		6 Days	
Payload	3 Trips per Day	4 Trips per Day	3 Trips per Day	4 Trips per Day	3 Trips per Day	4 Trips per Day
Closed Containers						
Total Containers 20.4[t]	**50**	**42**	**36**	**29**	**29**	**22**
Total Containers 21.4[t]	50	36	36	29	22	22
Open Top Containers						
Total Containers 22.4[t]	**50**	**36**	**36**	**29**	**22**	**22**
Total Containers 23.4[t]	43	36	36	29	22	22

Table 89 6 Day a Week Operation for 2005 (Author, 2006).

7 Day a Week Operation for 2005

Trips per Day	Parkhouse		Metro		Styx Mill	
	7 Days		7 Days		7 Days	
Payload	3 Trips per Day	4 Trips per Day	3 Trips per Day	4 Trips per Day	3 Trips per Day	4 Trips per Day
Total Containers 20.4[t]	**43**	**36**	**36**	**29**	**22**	**14**
Total Containers 21.4[t]	43	36	29	29	22	14
Open Top Containers						
Total Containers 22.4[t]	**43**	**29**	**29**	**22**	**22**	**14**
Total Containers 23.4[t]	36	29	29	22	22	14

Table 90 7 Day a Week Operation for 2005 (Author, 2006).

Appendix 12 Rail Transport Operation Container Numbers Using Closed Containers For 2005

The same set of tables (4) was used for each transfer station payloads:

20.4 tonne Payload Closed Container

304,148 [t] per annum 20.4[t] per Truck and Trailer / Trip Closed Containers						
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container lumbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	136867	2,632	439	376	43	37
Metro	100369	1,930	322	276	32	27
Styx Mill *	66912	1,287	215	184	21	18
	304148	**5849**	**975**	**836**	**96**	**82**
Number of Rail Wagons					**48**	**41**
20% Container Allowance for Peak Periods & Repairs					**19**	**16**
Numbers of Container Required including 20%					**115**	**98**
Set 2 Total Number of Containers (at Glasnieven)					96	82
Total Container Numbers					211	180

Table 91 20.4 tonne Payload Closed Container (Author, 2006).

21.4 tonne Payload Closed Container

304,148 [t] per annum 21.4[t] per Truck and Trailer / Trip Closed Containers						
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	136867	2,632	439	376	41	35
Metro	100369	1,930	322	276	30	26
Styx Mill *	66912	1,287	215	184	20	17
	304148	**5849**	975	836	91	78
Number of Rail Wagons					**46**	**39**
20% Container Allowance for Peak Periods & Repairs					**18**	**16**
Numbers of Container Required including 20%					**109**	**94**
Set 2 Total Number of Containers (at Glasnieven)					91	78
Total Container Numbers					200	172

Table 92 21.4 tonne Payload Closed Container (Author, 2006).

22.4 tonne Payload Open Top Container

304,148 [t] per annum	22.4[t] per Truck and Trailer / Trip			Open Top Containers		
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	136867	2,632	439	376	39	34
Metro	100369	1,930	322	276	29	25
Styx Mill *	66912	1,287	215	184	19	16
	304148	**5849**	975	836	87	75
Number of Rail Wagons					**44**	**38**
20% Container Allowance for Peak Periods & Repairs					**17**	**15**
Numbers of Container Required including 20%					**104**	**90**
Set 2 Total Number of Containers (at Glasnieven)					87	75
Total Container Numbers					191	164

Table 93 22.4 tonne Payload Open Top Container (Author, 2006).

23.4 tonne Payload Open Top Container

304,148 [t] per annum	23.4[t] per Truck and Trailer / Trip			Open Top Containers		
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	136867	2,632	439	376	37	32
Metro	100369	1,930	322	276	27	24
Styx Mill *	66912	1,287	215	184	18	16
	304148	**5849**	975	836	83	71
Number of Rail Wagons					**42**	**36**
20% Container Allowance for Peak Periods & Repairs					**17**	**14**
Numbers of Container Required including 20%					**100**	**86**
Set 2 Total Number of Containers (at Glasnieven)					83	71
Total Container Numbers					183	157

Table 94 23.4 tonne Payload Open Top Container (Author, 2006).

Appendix 13 Road Transport Operation Container Numbers Using Closed Containers Projected for 2015

The same set of tables (4) was used for each transfer station payloads:

Parkhouse

20.4 tonne Payload Closed Container

Parkhouse Transfer Station				
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
119,250		**20.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
112	16		18.6->19	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	5.3	4	6.3	4.8
Truck Numbers Selected	5	4	6	5
	5 Trucks	4 Trucks	6 Trucks	5 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Number of Containers	**30**	**24**	**36**	**30**
20% allowance	6	5	7	6
Total Containers	36	29	43	36

Table 95 20.4 tonne Payload Closed Container (Author, 2006).

21.4 tonne Payload Closed Container

Parkhouse Transfer Station				
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
119,250		**21.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
107	15.3->15		17.8->18	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	5	3.8	6	4.5
Number of Trucks	**5**	**4**	**6**	**5**
	5 Trucks	4 Trucks	6 Trucks	5 Trucks
Number of Containers	3 Trips **30**	4 Trips **24**	3 Trips **36**	4 Trips **30**
20% allowance	6	5	7	6
Total Containers	36	29	43	36

Table 96 21.4 tonne Payload Closed Container (Author, 2006).

22.4 tonne Payload Open Top Container

Parkhouse Transfer Station				2015
Waste per Annum [t]		Truck and Trailer / Trip [t]		
119,250		22.4		
Return Trips per Week	7 Day Operation		6 Day Operation	
102	14.6->15		17	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	5	3.8	5.7	4.3
Number of Trucks	5	4	6	4
	5 Trucks	4 Trucks	6 Trucks	4 Trucks
Number of Containers	3 Trips **30**	4 Trips **24**	3 Trips **36**	4 Trips **24**
20% allowance	6	5	7	5
Total Containers	36	29	43	29

Table 97 22.4 tonne Payload Open Top Container (Author, 2006).

23.4 tonne Payload Open Top Container

Parkhouse Transfer Station				2015
Waste per Annum [t]		Truck and Trailer / Trip [t]		
119,250		23.4		
Return Trips per Week	7 Day Operation		6 Day Operation	
98	14		16.4->16	
Number of Trips	3 Trips / Day	4 Trips / Day	3 Trips / Day	4 Trips / Day
	4.7	3.5	5.3	4
Number of Trucks	5	4	5	4
	5 Trucks	4 Trucks	5 Trucks	4 Trucks
Number of Containers	3 Trips **30**	4 Trips **24**	3 Trips **30**	4 Trips **24**
20% allowance	6	5	6	5
Total Containers	36	29	36	29

Table 98 23.4 tonne Payload Open Top Container (Author, 2006).

Metro Transfer Station

20.4 tonne Payload Closed Container

Metro				**2015**
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
87,450		**20.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
82	11.7->12		13.7->14	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	4	3	4.7	3.5
Number of Trucks	**4**	**3**	**5**	**4**
	4 Trucks	3 Trucks	5 Trucks	4 Trucks
Number of Containers	3 Trips **24**	4 Trips **18**	3 Trips **30**	4 Trips **24**
20% allowance	5	4	6	5
Total Containers	29	22	36	29

Table 99 20.4 tonne Payload Closed Container (Author, 2006).

21.4 tonne Payload Closed Container

Metro				**2015**
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
87,450		**21.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
79	11.3->11		13.2->13	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	3.7	2.8	4.3	3.3
Number of Trucks	**4**	**3**	**5**	**3**
	4 Trucks	3 Trucks	5 Trucks	3 Trucks
Number of Containers	3 Trips **24**	4 Trips **18**	3 Trips **30**	4 Trips **18**
20% allowance	5	4	6	4
Total Containers	29	22	36	22

Table 100 21.4 tonne Payload Closed Container (Author, 2006).

22.4 tonne Payload Open Top Container

Metro				2015
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
87,450		**22.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
75	10.7->11		12.5->13	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	3.3	2.8	4.3	3.3
Number of Trucks	**3**	**3**	**4**	**3**
	3 Trucks	3 Trucks	4 Trucks	4 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Number of Containers	**24**	**18**	**30**	**18**
20% allowance	5	4	6	4
Total Containers	29	22	36	22

Table 101 22.4 tonne Payload Open Top Container (Author, 2006).

22.4 tonne Payload Open Top Container

Metro				2015
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
87,450		**23.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
72	10.3->10		12	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	3.3	2.5	4	3
Number of Trucks	**3**	**3**	**4**	**3**
	3 Trucks	3 Trucks	4 Trucks	3 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Number of Containers	**24**	**18**	**30**	**18**
20% allowance	5	4	6	4
Total Containers	29	22	36	22

Table 102 22.4 tonne Payload Open Top Container (Author, 2006).

Styx Mill

20.4 tonne Payload Closed Container

Styx Mill				**2015**
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
58,300		**20.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
55	7.9-<8		9.2->9	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	2.7	2	3	2.3
Number of Trucks	**3**	**2**	**3**	**2**
	3 Trucks	2 Trucks	3 Trucks	2 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Number of Containers	**18**	**12**	**18**	**12**
20% allowance	4	2	4	2
Total Containers	22	14	22	14

Table 103 20.4 tonne Payload Closed Container (Author, 2006).

21.4 tonne Payload Closed Container

Styx Mill				**2015**
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
58,300		**21.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
52	7.4->7		8.7->9	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	2.3	1.8	3	2.3
Number of Trucks	**2**	**2**	**3**	**2**
	2 Trucks	2 Trucks	3 Trucks	2 Trucks
	3 Trips	4 Trips	3 Trips	4 Trips
Number of Containers	**12**	**12**	**18**	**12**
20% allowance	2	2	4	2
Total Containers	14	14	22	14

Table 104 21.4 tonne Payload Closed Container(Author, 2006).

22.4 tonne Payload Open Top Container

Styx Mill				2015
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
58,300		**22.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
50	7.1->7		8.4->8	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	2.3	1.8	2.6	2
Number of Trucks	**2**	**2**	**3**	**2**
	2 Trucks	2 Trucks	2 Trucks	2 Trucks
Number of Containers	3 Trips **12**	4 Trips **12**	3 Trips **12**	4 Trips **12**
20% allowance	2	2	2	2
Total Containers	14	14	14	14

Table 105 22.4 tonne Payload Open Top Container (Author, 2006).

23.4 tonne Payload Open Top Container

Styx Mill				2015
Waste per Annum [t]		**Truck and Trailer / Trip [t]**		
58,300		**23.4**		
Return Trips per Week	**7 Day Operation**		**6 Day Operation**	
48	6.9->7		8	
Number of Trips	**3 Trips / Day**	**4 Trips / Day**	**3 Trips / Day**	**4 Trips / Day**
	2.3	1.8	2.7	2
Number of Trucks	**2**	**2**	**3**	**2**
	2 Trucks	2 Trucks	2 Trucks	2 Trucks
Number of Containers	3 Trips **12**	4 Trips **12**	3 Trips **12**	4 Trips **12**
20% allowance	2	2	2	2
Total Containers	14	14	14	14

Table 106 23.4 tonne Payload Open Top Container(Author, 2006).

Appendix 14 **Rail Transport Operation Container Numbers Projected for 2015 Closed Containers**

The same set of tables (4) was used for each transfer station payloads:

20.4 tonne Payload Closed Container 2015

265,000 [t] per annum 20.4[t] per Truck and Trailer / Trip Closed Containers						
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	119,250	2,293	382	328	37	32
Metro	87,450	1,682	280	240	27	24
Styx Mill *	58,300	1,121	187	160	18	16
			849	**728**	**82**	**72**
20% Allowance for Peak Periods & Repairs					**16**	**14**
Total Numbers of Container Required					**98**	**86**
Set 2 Total Number of Containers (at Glasnieven)					**82**	**72**
Total Container Numbers					**180**	**158**

Table 107 20.4 tonne Payload Closed Container 2015(Author, 2006).

21.4 tonne Payload Closed Container 2015

265,000 [t] per annum 21.4[t] per Truck and Trailer / Trip Closed Containers						
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	119,250	2,293	382	328	36	31
Metro	87,450	1,682	280	240	26	22
Styx Mill *	58,300	1,121	187	160	17	15
			849	**728**	**79**	**68**
20% Allowance for Peak Periods & Repairs					**16**	**14**
Total Numbers of Container Required					**95**	**82**
Set 2 Total Number of Containers (at Glasnieven)					**79**	**68**
Total Container Numbers					**174**	**150**

Table 108 21.4 tonne Payload Closed Container 2015 (Author, 2006).

22.4 tonne Payload Open Top Container 2015

265,000 [t] per annum 22.4[t] per Truck and Trailer / Trip Open Top Containers						
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	119,250	2,293	382	328	34	29
Metro	87,450	1,682	280	240	25	21
Styx Mill *	58,300	1,121	187	160	17	14
			849	**728**	**76**	**64**
20% Allowance for Peak Periods & Repairs					**15**	**13**
Total Numbers of Container Required					**91**	**77**
Set 2 Total Number of Containers (at Glasnieven)					**76**	**64**
Total Container Numbers					**167**	**141**

Table 109 22.4 tonne Payload Open Top Container 2015 (Author, 2006).

22.4 tonne Payload Open Top Container 2015

265,000 [t] per annum 23.4[t] per Truck and Trailer / Trip Open Top Containers						
Transfer Station	**Waste per Annum [t]**	**Waste per Week[t]**	**Waste per Day 6 Day Operation [t]**	**Waste per Day 7 Day Operation [t]**	**Container Numbers 6 Day Op**	**Container Numbers 7 Day Op**
Parkhouse	119,250	2,293	382	328	33	28
Metro	87,450	1,682	280	240	24	21
Styx Mill *	58,300	1,121	187	160	16	14
			849	**728**	**73**	**63**
20% Allowance for Peak Periods & Repairs					**15**	**13**
Total Numbers of Container Required					**88**	**76**
Set 2 Total Number of Containers (at Glasnieven)					**73**	**63**
Total Container Numbers					**161**	**139**

Table 110 22.4 tonne Payload Open Top Container 2015 (Author, 2006).

Appendix 15 Hook and Arm Lifting System Operation

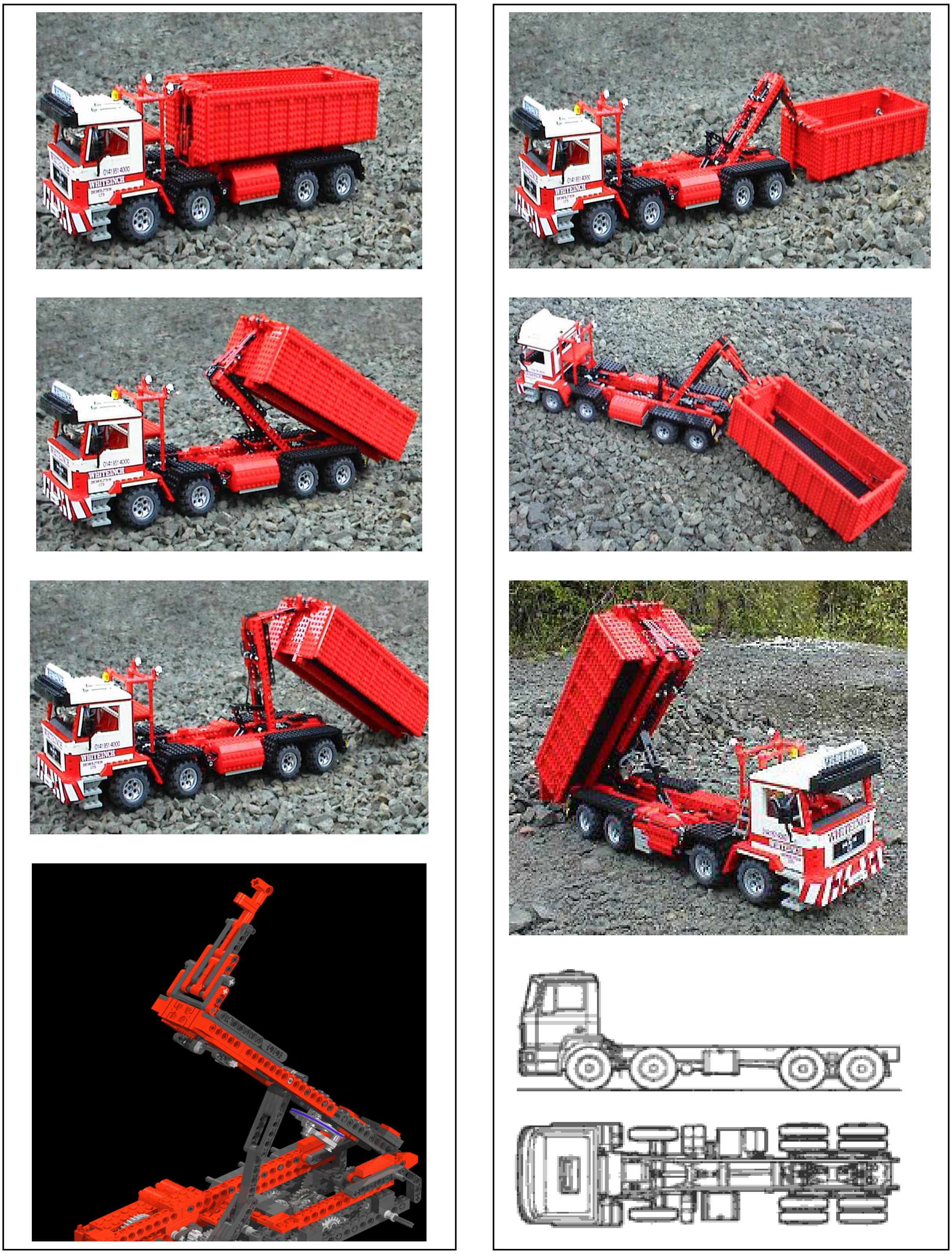
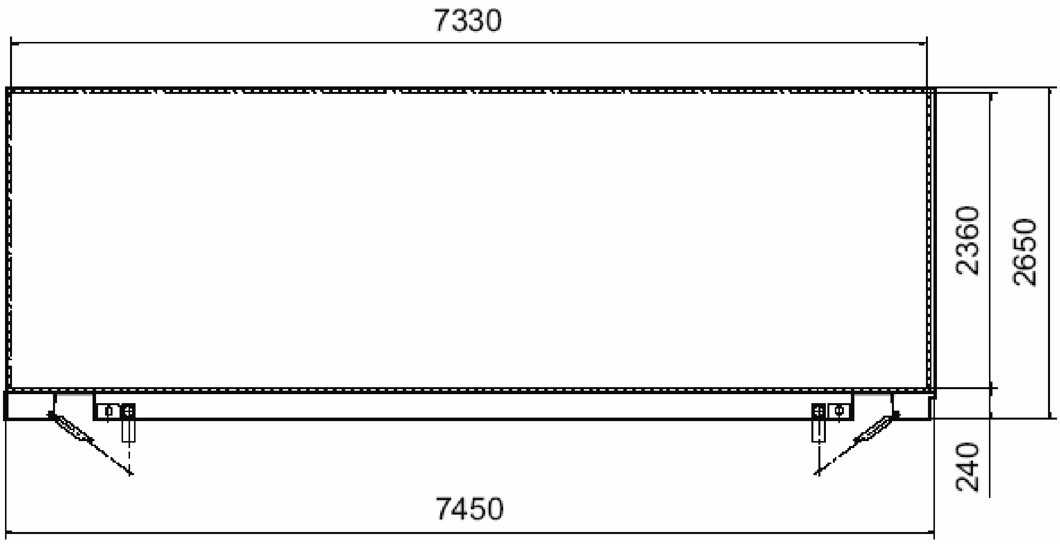


Figure 42 Hook and Arm Container Lifting System Operational Movements (Strata, 2006)

http://www.telepresence.strath.ac.uk/jen/lego/hooklift.htm

Appendix 16 Cargo Domino Container Specifications



Bezeichnung	Cod. -Profil	Abmessungen* aussen	innen	Ladevolumen
WB -TF-	C 20			
Länge		7450 mm	7330 mm	
Breite		2550 mm	2480 mm	
Höhe		2650 mm	2360 mm	etwa 42,2 m³
Ladevolumen	EUR-Paletten	120 x 80 cm		18 Stück
	POL-Paletten	120 x 100 cm		14 Stück
	RB (Rollbehälter)	82 x 68 cm		30 Stück
Gewichte	Gesamtgewicht Brutto			16 000 kg
	Eigengewicht Tara			2 800 kg
	Nutzlast Netto			13 200 kg
Bodengruppe	Domino Ausführung	240 mm		
Hecktüren	Doppelflügel mit 2 oder 3 Containerverschlüssen und Hebebühnen-Anschlag			
Ladungssicherung	2-Reihen Zurrschienen links und rechts, 3-Reihen Rundloch Zurrschienen im Dach und Boden			

Zubehör
- 2 Stück Absperrbalken
- 3 Stück vertikale Sperrstangen
- 1 Stück Dokumentenmappe (innen)

* Massabweichungen vorbehalten

(SBB, 2006c)

Appendix 17 Opus Report on Road Transport

Road Freight

While commuter and general commercial traffic is projected to grow by around 2% (compound) per year over the next 20 years, a significantly higher growth rate is projected
for heavy freight traffic.

Opus International Consultants Limited forecast that the number of freight trips in Canterbury
(excluding Christchurch) will increase by 170% over the next 20 years, or approximately
5% (compound) per year.37 Opus estimates that 72% of the increase in heavy freight traffic will originate in South Canterbury.

As a result of the expansion of dairy and irrigated arable farming in the area. 28% will originate in North Canterbury. Most of the traffic growth will be concentrated on State Highway 1.

ECAN, 2006
http://www.ecan.govt.nz/NR/rdonlyres/8C3C3264-F5EF-4F21-BEC5-67E141B78CB8/0/Part_C_Infrastructure.pdf

Appendix 18 Transwaste's Previous Investigation of a Rail Option

During a court application by Transwaste Canterbury Limited (TCL) to change conditions of the resource management consent for Kate Valley in June 2006, it was advised that the options of using rail as the principle mode of transport had been investigated prior to the original resource consent, however the rail option was rejected, due to:

- Variations in the daily quantities of solid waste (the projected decreasing amount of solid waste)
- The difficulties in locating a suitable and considerable rail siding near Kate Valley
- Problems of establishing rail siding in Christchurch
- Difficulty of truck and trailer units getting safely to and from the rail siding across State Highway One.

During public consultation on the landfill, TCL's application received many submissions from Waipara people, strongly opposed to the use of rail for solid waste transport, and particularly against the use of any siding in or near Waipara.

Because of the submissions, it was conclude that road transport would be able to provide a flexible and reliable service, which can be easily and economically adjusted for the expected reduction in solid waste quantities over time.

It was noted that the proposed system of using solid waste containers with standard ISO container bases did leave the rail option open for the future should circumstances change (including the economics of road transport). The court was not prepared to prohibit the use of rail transportation in the future, as requested by the Waipara District Residents Association (Hurunui District Council, 2006)

In the CCC yearly report ending 30th June 2002, adjacent to the Parkhouse Refuse Station, two parcels of land, totalling 1.5 ha, were strategically purchased for a total of $1.13m, to provide potential rail access and additional space for future solid waste minimisation activities (CCC, 2002).

Appendix 19 Location of Landfills and Transfer Stations in Canterbury 2004.

(CCC 2004)

OF INFRINGEMENT FEES CERTAIN BREACHES OF OVERLOADING PROVISIONS OF LAND TRANSPORT (ROAD USER) RULE 2004.

LAND TRANSPORT (OFFENCES AND PENALTIES) REGULATIONS 1999
SCHEDULES
[SCHEDULE 1B

RULE 2004 (61001) AND LAND TRANSPORT RULE: VEHICLE DIMENSIONS AND MASS 2002 (41001)

PART 3
OVERLOADING
Individual axles (table 1) Offence Infringement fee for that axle $

If the axle weight recorded or calculated, reduced by the appropriate amount specified in clause 5 of this Part, exceeds the maximum permitted weight on the axle by—

	Infringement fee for that axle $
- not more than 500 kg	150
- more than 500 kg but not more than 1 000 kg	350
- more than 1 000 kg but not more than 1 500 kg	600
- more than 1 500 kg but not more than 2 000 kg	900
- more than 2 000 kg but not more than 2 500 kg	1,250
- more than 2 500 kg but not more than 3 000 kg	1,700
- more than 3 000 kg but not more than 3 500 kg	2,250
- more than 3 500 kg but not more than 4 000 kg	2,900
- more than 4 000 kg but not more than 4 500 kg	3,650
- more than 4 500 kg but not more than 5 000 kg	4,550
- more than 5 000 kg but not more than 5 500 kg	5,600
- more than 5 500 kg but not more than 6 000 kg	6,850
- more than 6 000 kg but not more than 6 500 kg	8,300
- more than 6 500 kg	10,000

Page 2 of 4 Regulations of New Zealand 1/06/2006

http://www.legislation.govt.nz/libraries/contents/om_isapi.dll?clientID=968248528&in...

Groups of 2 or more consecutive axles and all axles of vehicle or combination of vehicles (table 2)
Offence Infringement fee for sum of axle weights $

If the total of the recorded or calculated weights on the axles, reduced by the appropriate amount specified in clause 5 of this Part, exceeds the maximum permitted weight by—

	Infringement fee for that axle $
- not more than 1 000 kg	150
- more than 1 000 kg but not more than 2 000 kg	350
- more than 2 000 kg but not more than 3 000 kg	600
- more than 3 000 kg but not more than 4 000 kg	900
- more than 4 000 kg but not more than 5 000 kg	1,250
- more than 5 000 kg but not more than 6 000 kg	1,700
- more than 6 000 kg but not more than 7 000 kg	2,250
- more than 7 000 kg but not more than 8 000 kg	2,900
- more than 8 000 kg but not more than 9 000 kg	3,650
- more than 9 000 kg but not more than 10 000 kg	4,550
- more than 10 000 kg but not more than 11 000 kg	5,600
- more than 11 000 kg but not more than 12 000 kg	6,850
- more than 12 000 kg but not more than 13 000 kg	8,300
- more than 13 000 kg	10,000

1. Each axle weight—
For each axle the weight on which exceeds the maximum permitted weight for such an axle, the appropriate overloading infringement fee shown in table 1 is payable.

2. or more consecutive axle weights—
For each group of 2 or more consecutive axles of a vehicle or combination of vehicles the total of the weights of which exceeds the total of the weights permitted on a group of 2 or more consecutive axles with the recorded distance between the centers of the first and the last axle of the group, the appropriate overloading infringement fee shown in table 2 is payable.

3. Total axle weight of vehicle—
For each vehicle the total of the axle weight of which exceeds the permitted total of axle weights for a vehicle with the recorded distance between the centres of the first and last axle of the vehicle, the appropriate overloading infringement fee shown in table 2 is payable.

4. Total axle weight of combination of vehicles—

For each combination of vehicles the total of the axle weight of which exceeds the permitted total of axle weights for a combination of vehicles with the recorded distance between the centre of the first axle of the first vehicle and the centre of the last axle of the last vehicle, the appropriate overloading infringement fee shown in table 2 is payable.

5. Weighing tolerances—

The axle weight recorded or calculated or, in the case of an offence referred to in table 2, the total of the recorded or calculated weights on the axles, **[**is to**]** be reduced by the following amounts:
(a) 0.3 tonnes on any front steering axles (excluding any axles on a trailer) for which the
legal maximum weight does not exceed 11 tonnes:
(b) 0.5 tonnes for any weight recorded or calculated where the legal maximum weight does not exceed 11 tonnes, except in a case to which paragraph (a) applies:
(c) 1.0 tonne for any weight recorded or calculated where the legal maximum weights exceeds 11 tonnes but does not exceed 33 tonnes:
(d) 1.5 tonnes for any weight recorded or calculated where the legal maximum weight exceeds 33 tonnes but does not exceed 60 tonnes:
(e) 3.0 tonnes for any weight recorded or calculated where the legal maximum weight exceeds 60 tonnes.**]**

Appendix 21 Timeline

Dissertation Timeline	####				Jan-05				####				####				####				####				####				####				####				####				####				####				####				Jan-06				####			
Preliminary Planning	X	X	X	X																																																								
Information Gathering					X	X	X			X	X	X						X	X						X																																			
Compiling proposal					X	X	X			X	X																																																	
A literature review			X	X	X	X	X				X	X	X	X																																														
Submit dissertation proposal										X																																																	
Visit to the Kate Valley site																																				X																								
Visit to the Glasnevin Site																																																												
Number crunching																																							X	X	X	X					X	X												
Consideration of transport options																												X	X	X	X	X			X																									
Consultation with the stakeholders																					X				X																						X	X		X										
Evaluating stakeholders feedback																									X	X	X																						X	X										
Identifying outputs																															X																				X				X					
figures & costing																																X			X	X	X	X																						
Finalising results / figures / costing																												X	X	X																														
Evaluation of the economic options																										X																																		
In depth analysis of outputs																																X			X																									
OKA cost benefit analysis																																			X	X	X																							
In depth analysis of outputs																																				X																								
Evaluating of HSE																																																												
Analysis of triple bottom line areas																																				X	X	X	X																					
Evaluate / Discuss options																																					X	X	X																					
Finalise Research																																								X	X																			
Conclusion																																										X	X																	
Submit draft dissertation																																												X																
Revision of final draft																																																												
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Binding																																																												
Seminar Presentation Lincoln																																																												
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Appendix 22 Glossary of Terms

Household Hazardous	Hazardous or potentially hazardous waste originating from domestic sources in small quantities.
Incinerator	A facility for the combustion of solid waste. Often associated with energy recovery.
Kerbside recycling	The roadside collection materials separated for the purposes of recycling.
Kitchen Waste	Fruit, vegetable and other food scraps arising from domestic or commercial kitchens.
Landfill	A controlled site for the deposition of solid waste on land.
Leachate	The liquid effluent produced by the action of water percolating through a landfill. May contain traces of any materials disposed of in the landfill.
Management	The efficient use of resources and the effective control of systems in the execution of a plan.
Material recovery facility (MRF)	Plant and equipment for sorting and pre-processing materials from the waste stream for reuse, recycling or resource recovery.
Municipal Solid Waste	The discarded materials, substances, objects or refuse that originate from domestic, business and industrial sources, which are typically disposed of in municipal type landfills, but not including industrial hazardous or 'special wastes'.
Organic Waste	Waste material which is comprised of animal or vegetable matter and typically from which a compost can be produced.
Putrescible Waste	Waste that can become putrid, offensive or unpleasant (usually applied to food or animal products).
Recycling	The reprocessing or re manufacturing of material into new or different products.
Reduction	The design, manufacture, acquisition and reuse of materials so as to minimise the quantity and/or toxicity of waste produced. Source reduction prevents waste either by redesigning products or by otherwise changing societal patterns of consumption use and waste generation.
Refuse	See Municipal Solid Waste.
Residue Disposal	The disposal, in a environmentally safe manner, of the remains of the solid waste stream after source reduction, reuse, recycling and resource recovery activities.
Resource Recovery	The extraction an utilisation of energy, materials or biomass from the waste stream.
Reuse	The repeated or continued use of a product in its original form.
Rubble	Inert material typically arising from construction and demolition activities, including concrete, bricks, plaster and stones.
Solid Waste Stream	The total of all solid waste components and the process through which they move from point of generation to disposal.
Source Separation	The segregation of specific materials or components of the waste stream at the point of generation for separate management.
Special Wastes	Wastes (not hazardous) that require special handling considerations during disposal (e.g. car tyres and refrigerators).
The Natural Step	A framework for sustainability that encompasses 4 basic principles: 1) substances must not be extracted from the earth at a rate faster than they can be replaced (depletion); 2) substances must not build up on earth at a rate faster than the earth can assimilate them (pollution); 3) biodiversity must be maintained; 4) resources on the earth must be shard fairly (equity).
Transfer Station	A facility where waste is transferred from smaller vehicles (cars, trailers, trucks) into larger vehicles for transport to a disposal site.
Treated Wood	Wood that has been chemically altered in such a way that makes it or its parts potentially hazardous (e.g. wood that has been coated with lead-based paint, impregnated with preservatives and manufactured using binding agents).
Triple Bottom Line Reporting	A reporting system that enables organisations to report and respond appropriately to their environmental, social and economic performance.

Untreated Wood	Wood that is not treated (see treated wood).
Waste	Any material that is unwanted or unvalued and discarded or discharged by its owner.
Waste Audit	A statistical analysis of the waste stream in terms of quantity, composition, source and management.
Waste Composition	The characteristics and quantification of the materials that make up the waste stream.
Waste Generator	Any person or organisation that consumes goods and services resulting in additions to the waste stream.
Waste Minimisation	Any technique, process or activity which either avoids, eliminates or reduces the production of waste, or allows reuse or recycling of materials removed from the waste stream.
Waste stream	The flow of materials from a point of generation to ultimate disposal.

Anaerobic Digestion	The biological decomposition of biomass under anaerobic conditions (without oxygen) within an enclosed system. Associated with energy recovery.
Biomass	Materials or products produced from plants or animals (e.g. garden and kitchen waste, wood, paper, cardboard and wool).
Cleaner Production	Producing environmentally sound products or services that use energy and resources efficiently and avoid or reduce the amount of waste produced, resulting in fewer costs
Cleanfill Material	Material that does not undergo any physical, chemical, or biological transformations that will cause adverse environmental effects or health effects once it is placed in a cleanfill.
Co-Disposal	The disposal of appropriately treated hazardous wastes by mixing them in an informed and predetermined manner, with municipal refuse, so as to use the biochemical processes operating within the landfill to reduce the environmental impact from the mixed waste to an insignificant level.
Commercial Waste	That part of the waste stream originating from commercial sources (e.g. from the production, wholesaling or retailing of products).
Compost	The relatively stable decomposed organic material resulting from the composting process.
Composting	The controlled biological decomposition of biomass under aerobic conditions (with oxygen).
Construction and Demolition waste	Materials in the waste stream which arise from construction, refurbishment or demolition activities including roading, earthworks and civil engineering.
Diversion	Redirecting material in the waste stream, either at the point of generation or some other time before final disposal.
Domestic waste	That part of the waste stream originating from households, typically garden and kitchen waste and refuse disposed of in the Council black rubbish bags.
Environment	Ecosystems and their component parts, including people and communities, all natural and physical resources and amenity values. Including the environment within and around Christchurch, adjacent regions and the wider environment beyond, or any thing that affects or is affected by the environment.
Garden Waste	Leaves, grass clippings, prunings, branches and other organic material discarded from parks, gardens or sections.
Hazardous Waste	Solid or liquid wastes which have properties that could pose dangers to human health, property or the environment if they are not properly treated, stored, transported, disposed of or otherwise properly managed. Without limiting this definition, a waste is considered hazardous if it is ignitable, corrosive, reactive, toxic or radioactive; and includes Health Care, Clinical and related wastes, with the exception of general and recyclable wastes as defined in AS 3816: 1998 "Health Care Waste Management".